PROPOSAL OF SETTING UP A JOINT ESC / EAEE WORKING (TASK) GROUP ON UPDATING OF THE CONCEPT OF SEISMIC INTENSITY AND OF THE INTENSITY SCALES

Horea SANDI[*]

ABSTRACT

The proposal presented subsequently was forwarded by the author, in August 2010, on the eve of the 14th European Conference on Earthquake Engineering, to:

- Prof. Atilla Ansal, Secretary General, EAEE;
- Dr. Mariano García-Fernández, Secretary General, ESC.

This proposal was to a high extent a follow up of the project "Quantification of seismic action on structures" (2005-2008), in which research groups of institutes of Romania (coordination), Russian Federation and Republic Moldova were involved. A summary outcome of the project referred to is represented by the volume [Sandi & al., 2010a]. A brief presentation of the volume referred to is given in its foreword, reproduced in Annex II. The correspondence related to the submission of the proposal is reproduced in Annex III. A paper on this subject, [Sandi & al., 2010b], presented at the 14th European Conference on Earthquake Engineering, is also reproduced in this issue of the journal.

Keywords: Intensity scales, instrumental criteria, spectral contents

REZUMAT

Propunerea prezentată în continuare a fost înaintată de autor, în august 2010, în ajunul celei de a 14-a Conferințe Europene de Inginerie Seismică, domnilor:

- Prof. Atilla Ansal, Secretar General, EAEE;
- Dr. Mariano García -Fernández, Secretar General, ESC.

Această propunere fost în mare măsură o urmare a proiectului "Quantification of Seismic action on structures" (2005-2008), în care au fost angajate grupuri de cercetare din România (coordonare), Federația Rusă şi Republica Moldova. Un rezultat de sinteză al proiectului menționat este reprezentat de volumul [Sandi & al., 2010a]. O scurtă prezentare a acestui volum este dată în prefața sa, reprodusă în Anexa II. Corespondența legată de înaintarea acestei propuneri este reprodusă în Anexa III. O comunicare asupra acestui subiect, [Sandi & al., 2010b], prezentată la cea de a 14-a Conferință Europeană de Inginerie Seismică, este, de asemenea, reprodusă în acest număr al revistei.

Cuvinte cheie: scări de intensități, criterii instrumentale, compoziție spectrală

1. THE PROPOSAL

1.1. Reasons

The concept of seismic intensity is quite popular, but its sense is rather vague. If compared with the functions that may be expected to be fulfilled by it, some essential shortcomings may be revealed. Two of them must be emphasized primarily:

1. According to well established engineering knowledge, seismic intensity, which may be referred to as a destructive potential of ground motion, differs in fact for different spectral bands, depending upon the spectral features of ground motion. In case one looks at intensity scales of traditional nature, like MSK or EMS-98, this aspect is unfortunately disregarded and this fact may (and did it in effect sometimes) lead to erroneous conclusions on the actual intensities, with corresponding consequences for seismic zonation (an illustrative case is presented in [Sandi, Borcia, 2010]).

2. The accelerographic instrumentation is already quite well developed in many countries and extremely rich information of highest interest has been acquired on this basis. This hard information must be used when available, given the fact that it is of considerably higher accuracy than hastily collected information obtained during post-event field surveys. Unfortunately,

[*] Institute of Geodynamics of the Romanian Academy, Bucharest & Academy of Technical Sciences of Romania

the instrumental criteria specified by the MSK scale are questionable and may lead to coarse errors, while such criteria are totally absent in EMS-98. Note that F. Aptikaev conducted extensive statistical analyses [Aptikaev, 2005] which revealed part of the weaknesses of the instrumental criteria of the MSK scale.

Besides this, to be mentioned that recent studies of Russia (F. Aptikaev & al.[Aptikaev (editor), 2006]) on the development of intensity scales revealed the need to regionally adapt macroseismic criteria to the features of the local building stock (a convergent question was briefly raised by R. Spence in relation to the recent Haiti experience).

Following proposals are intended to favour an improvement in this field.

1.2. Proposals of action

The action proposed is to form a *Joint Working (Task) Group of ESC and EAEE* on ***UPDATING OF THE CONCEPT OF SEISMIC INTENSITY AND OF THE INTENSITY SCALES***, to be in charge of this important and quite sophisticated problem.

The executive committees of ESC and EAEE should proceed to enquiries to the corresponding national organizations, in order to identify specialists competent and available for these activities. I think that a participation of four to six specialists, desirably the same number on behalf of the two European organizations, would be appropriate.

1.3. Main objectives proposed

1. To meet an agreement about some principles:

- the need to explicitly consider the spectral contents of ground motion;
- the need to develop and specify improved instrumental criteria for intensity assessment;
- the need to consider the diversity of regional construction stock (perhaps, by means of specifying some general principles and criteria and leaving freedom for the development of regional specific criteria).

2. To adopt an explicit system of instrumental criteria of intensity assessment, possibly a flexible one, to enable analysts to gather a comprehensive picture of the ground motion features (a possible system, quite successfully used according to my opinion, is referred to subsequently and the results of its use are illustrated in Annex 1).

3. To add to the currently used rules/ recommendations of post-event survey techniques the explicit requirement of gathering information concerning the spectral band for which the data acquired is relevant.

4. To develop recommendations for the revision of "historical" information, by means of assessing in each case the spectral band for which it is relevant.

5. To reconsider the structure of the system of visual criteria of intensity scales, by providing some general principles of assessment and by leaving room for the development of annexes concerning specific regional criteria.

1.4. Some comments

The activities proposed might be impeded by various factors. An example: in 1991 I participated in a meeting of the group in charge for the development of EMS, where I advocated the consideration of the spectral contents of ground motion. There was no reaction. *Unless the importance of spectral contents is well understood and accepted as one of the starting points of activities, there is no hope of success of my proposal*.

A flexible system of instrumental criteria was proposed in [Sandi, Floricel, 1998]. Its use for a wide diversity of ground motions appeared to be at least satisfactory, even if a recalibration could be considered. To illustrate its use, some illustrative cases are reproduced in Annex I.

REFERENCES

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P.3. Aptikaev, F. (editor), *Project of Russian Seismic Intensity Scale RIS-04*, Proc. First European Conf. on Earthquake Engineering and Seismology, Geneva, Switzerland, (Paper No. 1291), 2006

P.12. Sandi, H., Borcia, I. S., *A major reason to fundamentally revise the traditional concept of macroseismic intensity: to avoid possible zonation mistakes. An illustrative case*, 2010

P.1. Sandi, H., Floricel, I., *Some alternative instrumental measures of ground motion severity*, Proc. 11-th European Conf. on Earthquake Engineering, Paris, 1998

Note: the indices P.1, P.2 etc. provide information on the order in which the papers are presented (also) in the volume „Quantfication of seismic action on structures", by H. Sandi, F. Aptikaev, I. S. Borcia, O. Erteleva & V. Alcaz, AGIR Publishing House, Bucharest, 2010.

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Horea Sandi,
E-mail: sandi@geodin.ro,
horeasandi@yahoo.com.

ANNEX I

ILLUSTRATIVE PRESENTATION OF ACCELEROGRAMS, RESPONSE SPECTRA AND DISCRETIZED INTENSITY SPECTRA FOR SOME REFERENCE RECORDS

(excerpts from [Borcia & Sandi, 2010])

1. INTRODUCTION

This annex is intended to illustrate (for a few reference cases) the features of the alternative intensity evaluations presented in [Sandi & Floricel, 1998]. It may be considered a system of case studies concerning ground motions having had various, quite diverse, features. It represents also a factual support to the philosophy of radical revision of the concept of seismic intensity, as presented in [Sandi, 2006]. The results presented illustrate the outcome of use of alternative processing techniques and provide a view on their convergence and correlation.

The basic instrumental data selected for being used for this were taken from the records obtained:

- in El Centro for the Imperial Valley earthquake of 1940.05.18 (M_S = 7.0);
- in Mexico City / Segretería de Comunicaciones y Transportes for the Guerrero / Michoacán earthquake of 1985.09.19 (M_S = = 8.1) and
- in Bucharest-INCERC, Romania, during the strong Vrancea earthquake of 1977.03.04 (M_{GR} = 7.2).

2. TECHNIQUES USED FOR ILLUSTRATION

A summary view on the alternative ways of quantification of seismic intensitites considered, according to [Sandi & Floricel, 1998], presented in [Aptikaev & al., 2008], is given in Table 1.

The basic definitions of the intensity measures used in the paper are reproduced in Table 2.

Table 1.

System of instrumental criteria for intensity assessment

Name	Symbols used for intensities: * global ** related to a frequency *** averaged upon a frequency interval			Source of definition / comments
	*	**	***	
Spectrum based intensities	I_S	$i_S(\varphi)$	$i_S^{\sim}(\varphi', \varphi'')$	Linear response spectra for absolute accelerations and velocities / use of *EPA*, *EPV*, redefined as *EPAS*, *EPVS* respectively (see relations (10)); averaging rules specified
Intensities based on Arias' type integral	I_A	$i_d(\varphi)$	$i_d^{\sim}(\varphi', \varphi'')$	Quadratic integrals of acceleration of ground (for I_A), or of pendulum of natural frequency φ (for $i_d(\varphi)$) / extensible to tensorial definition; averaging rules specified
Intensities based on quadratic integrals of Fourier images	I_F ($\equiv I_A$)	$i_f(\varphi)$	$i_f^{\sim}(\varphi', \varphi'')$	Quadratic integrals of Fourier image of acceleration (for I_F), or quadratic functions of Fourier images (for $i_d(\varphi)$) / extensible to tensorial definition; averaging rules specified.

Table 2.

Basic definitions of I_S, i_s (φ), I_A, and i_d (φ)

Intensity measures	Definitions	Notes
I_S	$I_S = \log_4 (EPAS \times EPVS) + 8.0$	$EPAS = \max_\varphi s_{aa} (\varphi, 0.05) / 2.5$ $EPVS = \max_\varphi s_{va} (\varphi, 0.05) / 2.5$
i_S (φ)	$i_S (\varphi) = \log_4 [s_{aa} (\varphi, 0.05) \times s_{va} (\varphi, 0.05)] + 7.70$	s_{aa} (φ, 0.05): absolute acceleration resp. sp. S_{va}(φ, 0.05): absolute velocity resp. sp.
I_A	$I_A = \log_4 \{\int [w_g (t)]^2 \, dt\} + 6.75$	$w_g (t)$ ground motion acceleration
i_d (φ)	$i_d (\varphi) = \log_4 \{\int [w_a (t, \varphi, 0.05)]^2 \, dt\} + 5.75$	$w_a (t, \varphi, 0.05)$: absolute acceleration of pendulum with eigenfrequency φ and 5 % critical damping

The analytical expressions of the alternative intensity measures referred to in Table 1 were first given in [Sandi & Floricel, 1998]. They correspond to the assumption on which the instrumental criteria of the MSK rely, namely the assumption that a jump of one intensity unit corresponds to a factor 2.0 of increase (or decrease respectively) of the values of *PGA* (peak ground acceleration), *PGV* (peak ground velocity) *PSD* (peak seismoscope displacement for the Medvedev seismoscope having a natural period of 0.25 s and a logarithmic decrement of 0.5). After having postulated the calibration of a constant that is specific to the measure I_S referred to in the table, the constants for the other measures referred to were selected in a way to lead to a minimum expected (quadratic) deviation for a quite rich system of instrumental data, obtained during the strong Romania earthquakes of 1977.03.04 (M_{GR} = 7.2), 1986.08.30 (M_{GR} = 7.0), 1990.05.30 (M_{GR} = 6.7) and 1990.05.31 (M_{GR} = 6.1).

3. ILLUSTRATIVE DATA AND RESULTS

The accelerograms along the two horizontal directions and the corresponding spectral characteristics, for the records referred to, are given in Table 4. The response spectra given in the third column of the table are presented in semi-logarithmic format: logarithmic scale of natural periods in the abscissa and natural scale of spectral accelerations in the ordinate.

The intensity spectra given in the fourth column are presented in the same format. The coloured plots are in red for the response spectrum based intensity spectra, $i_s^{\sim}(\varphi', \varphi'')$, and in blue, respectively, for the intensity spectra based on destructiveness characteristics, $i_d^{\sim}(\varphi', \varphi'')$.

The data presented in the last column of Table 4 pertain respectively to:

- the global intensity I_S, referred to in Table 1;
- the averaged intensity I_{S1}, which means

$$I_{S1} = i_s^{\sim}(0.25 \text{ Hz}, 16.0 \text{ Hz}) \qquad (1)$$

for the averaged intensity $i_s^{\sim}(\varphi', \varphi'')$ referred to in Table 1;

- the global intensity I_A, referred to in Table 1;

Table 3.

Summary of results of secondary processing for sample earthquake motions, N. America & Vrancea

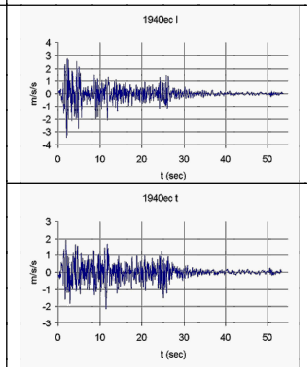
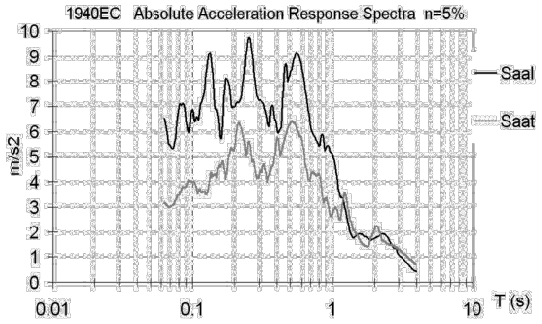
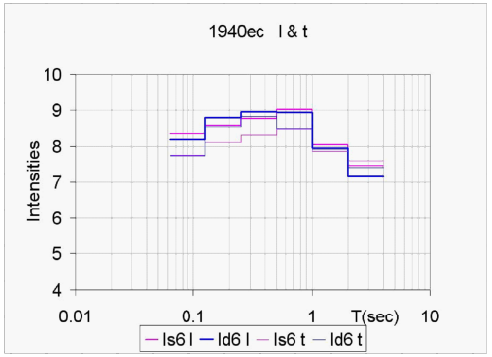
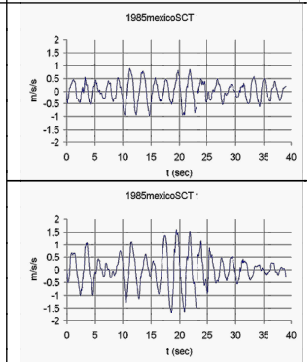
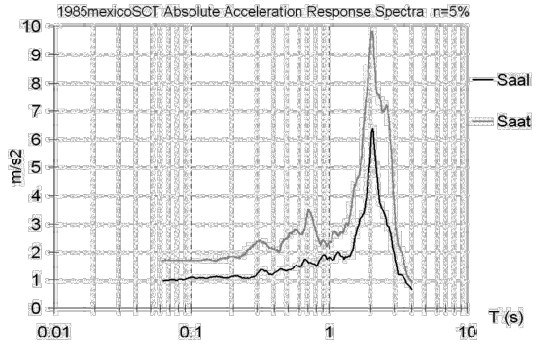
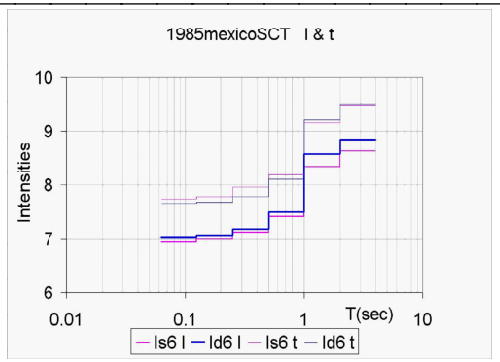
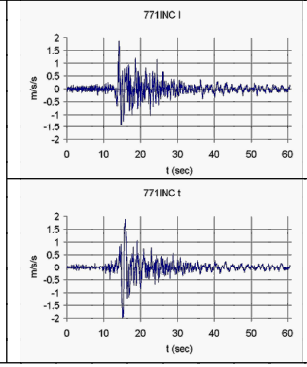
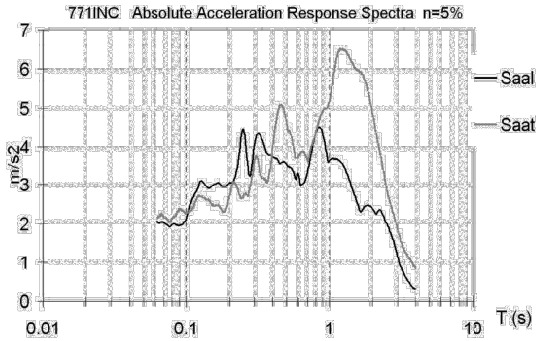
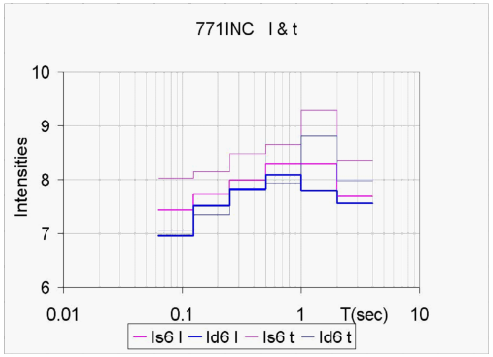
No	Station code	PGA *l*	PGA *t*	I_{S1} *l*	I_{S1} *t*	I_{S1} *lt*	I_S *l*	I_S *t*	I_S *lt*	I_{D1} *l*	I_{D1} *t*	I_{D1} *lt*	I_A *l*	I_A *t*	I_A *lt*	Record code
1	ELC0	3.4380	2.1370	8.52	8.09	8.34	8.18	7.80	8.01	8.56	8.31	8.44	8.55	8.30	8.43	1940ec
2	SCT	0.9641	1.6760	7.90	8.72	8.42	8.55	9.16	8.92	8.09	8.72	8.47	8.03	8.64	8.40	1985 mexico SCT
3	INC	1.8840	2.0690	7.97	8.63	8.37	7.64	8.37	8.09	7.70	8.04	7.89	7.67	7.99	7.85	771INC

Note: indices used
- *l* (longitudinal): direction *X* of record;
- *t* (transversal): direction *Y* of record;
- *1* (one): averaging of frequency dependent intensities over the frequency interval (0.25 Hz, 16.0 Hz);
- (no index): global intensities.

Units used for kinematic parameters: m, m/s, m/s^2.

Table 4.

Illustrative ground motion characteristics

No.	General data on event and on record site	Characteristics of ground motion along two orthogonal horizontal directions			Magnitudes and global intensities
		Accelerograms	Response spectra for absolute acccelerations (5% critical damping)	Intensity spectra : $i_s^{\sim}(\varphi', \varphi'')$, red, and $i_d^{\sim}(\varphi', \varphi'')$, blue, averaged upon 6 dB intervals	
1	*Source*: USA, Ca, Imperial Valley 1940.05.18 φ , λ: 32.73, -115.45 *Record site*: El Centro *Code*: 1940ELC φ , λ: 39.72, -115.55				M_S: 7.0 I_S: 8.01 (8.18, 7.80) I_S1: 8.34 (8.52, 8.09) I_A: 8.43 (8.55, 8.30) I_D1: 8.44 (8.56, 8.31)
2	*Source*: N. A. / Cocos Plates (Mexico) 1985.09.19 φ , λ: 18.08, -102.94 *Record site*: Mex. City SCT *Code*: 1985SCT φ , λ: 19.43, -99.13				M_S: 8.1 I_S: 8.92 (8.55, 9.16) I_S1: 8.42 (7.90, 8.72) I_A: 8.40 (8.03, 8.64) I_D1: 8.47 (8.09, 8.72)
3	*Source*: Romania, VSZ φ , λ: 45.34, 26.30 1977.03.04 *Record site*: Bucharest / INCERC *Code*: 771INC φ , λ: 44.44, 26.16				$M_{G\text{-}R}$: 7.2 I_S: 8.09 (7.64, 8.37) I_S1: 8.37 (7.97, 8.63) I_A: 7.85 (7.67, 7.99) I_D1: 7.89 (7.67, 8.04)

- the averaged intensity I_{A1}, which means

$$I_{A1} = i_d^{\sim}(0.25 \text{ Hz}, 16.0 \text{ Hz}) \qquad (2)$$

for the averaged intensity $i_d^{\sim}(\varphi', \varphi'')$ referred to in Table 3.

Note:

- indices used:
  - *l* (longitudinal): direction *X* of record;
  - *t* (transversal): direction *Y* of record;
  - *1* (one): averaging of frequency dependent intensities over the frequency interval (0.25 Hz, 16.0 Hz);
  - (no index): global intensities;
- units used for kinematic parameters: m, m / s, m / s^2.

4. FINAL CONSIDERATIONS

A look at the data of Table 4 makes it possible to derive following remarks and conclusions:

1. The main goal of the analysis presented in [Sandi & Borcia, 2010] was primarily that, of investigating the degree to which there exists a satisfactory convergence between the alternative ways of quantification of seismic intensity by using instrumental (basically accelerographic) information. The problem of option between alternative ways of calibrating the outcome of processing instrumental data based information was not dealt with. This is the object of developments and discussions of [Aptikaev & al., 2008] and [Borcia & al., 2010].

2. The system of alternative intensity measures used in this case, which relies on the calibrations adopted in [Sandi & Floricel, 1998], implicitly accepts the use of a geometric progression with a ratio 2.0 (corresponding to a jump of one intensity degree), as adopted in the frame of the MSK scale, which was (quite consistently) criticized in the frame of [Aptikaev, 2005], [Aptikaev & al., 2006]; [Aptikaev & al., 2008]. The authors believe on the other hand that this fact does not influence negatively the sense of results obtained.

3. The results presented are related to a system of records covering a quite wide range of global intensities and of spectral features of ground motion. So, they provide a quite comprehensive view on the relationships between classical response spectra on one hand and the various ways of intensity quantification explored.on the other hand. One may emphasize in this connection the picture on the ways used for intensity quantification and on the ways in which the ground motion features are reflected in this frame.

4. A look at the results presented makes obvious a good convergence between the outcomes of using alternative measures of intensity, on one hand in case one considers global intensities, on the other hand in case one considers intensities related to some definite spectral bands. The deviations between the alternative results provided by the use of alternative intensity measures respectively are in general lower than the differences that can be discriminated in case of performing macro seismic estimates.

5. The use of the measures concerning intensities related to various spectral bands provides an in depth view on the features of ground motion, as well as a radical increase of the quantity of information, which exceeds by far the information that can be provided by the traditional approach relying on the use of macro seismic estimates.

6. The degree of accuracy and of certainty provided by the use of instrumental information is generally higher than what can be provided by performing macro seismic estimates.

7. It may be stated that the system of measures $<I_A, i_d^{\sim}(\varphi', \varphi'')>$ is more stable than the system of measures $<I_S, i_s^{\sim}\varphi', \varphi'')>$, in the sense that the scatter is lower. This may compensate for the additional efforts required by the corresponding computations.

8. An additional advantage to be considered in relation to the system $<I_A, i_d^{\sim}(\varphi', \varphi'')>$ is represented by the fact that an extension to tensorial definitions is easily feasible, and this makes it possible to look for predominant

directions of seismic action (related to the motion as a whole, or to various spectral bands respectively.

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Aptikaev, F., Borcia, I. S., Erteleva, O., Sandi, H., Alcaz, V., *Development of instrumental criteria for intensity estimate. Some studies performed in the frame of a NATO project*, Proc. 14-th World Conf. on Earthquake Engineering, Beijing, China (Paper No. 02-0042), 2008, Paper P.8, *Quantification of seismic action on structures*, AGIR Publishing House, Bucharest

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Borcia, I. S., Sandi, H., Aptikaev, F., Erteleva, O., Alcaz, V., *Some statistical results related to the correlation of macro seismic estimates with instrumental estimates of seismic intensity*, Paper P.9, *Quantification of seismic action on structures*, AGIR Publishing House, Bucharest, 2010

Sandi, H., *Bridging a gap between seismologists and engineers: possible restructuring of the intensity scale(s)*, Proc. First European Conf. on Earthquake Engineering and Seismology, Geneva, Switzerland, (Paper No. 571), 2006, Paper P.4, *Quantification of seismic action on structures*, AGIR Publishing House, Bucharest

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Sandi, H., Borcia, I. S., *A major reason to fundamentally revise the traditional concept of macro seismic intensity: to avoid possible zonation mistakes. An illustrative case*, Paper P.12, *Quantification of seismic action on structures*, AGIR Publishing House, Bucharest, 2010

Sandi, H., Floricel, I., *Some alternative instrumental measures of ground motion severity*, Proc. 11-th European Conf. on Earthquake Engineering, Paris, 1998, Paper P.1, *Quantification of seismic action on structures.* AGIR Publishing House, Bucharest

ANNEX II

FOREWORD
to
"QUANTIFICATION OF SEISMIC ACTION ON STRUCTURES"

(AGIR Publishing House, Bucharest, 2010)
Authors: Horea SANDI, Felix APTIKAEV, Ioan Sorin BORCIA, Olga ERTELEVA, Vasile ALCAZ

by Horea SANDI – Project Director & Volume Editor

1. GENERAL

The concept of *intensity of the seismic ground motion*, that has already existed for a rather long time, in order to evaluate the severity of seismic ground motion during one earthquake, at a certain geographic point (or upon a limited geographic area, for which this severity is believed to be about the same), is widely popular. However, the ways in which this concept is understood may differ considerably. One could even observe a scale of the levels of understanding of this concept. We have at one end laypersons and, unfortunately, quite frequently, some mass media agents, who do not even make a difference between the concepts of ground motion intensity and of earthquake magnitude. At the other end we have the professionals, who would like to adapt this concept in a way to make it as suitable as possible to the requirements of their activities. This volume is aimed to people of this latter orientation.

This volume relies on two main sources. Firstly, we have the long term and fruitful activities of the Russian school of seismology, for which the group of the Institute of Physics of the Earth of Moscow

played a dominant scientific role, contributing considerably to the gradual improvement of knowledge and achievements related to the traditional concept of seismic intensity. Secondly, we have the activities of a group that first came into existence in INCERC (National Building Research Institute) Bucharest, in response to the impact of the destructive Vrancea earthquake of 1977.03.04, with the task of carrying out an in depth post – earthquake survey.

An immediate incentive to organize cooperative activities on this theme was due to a meeting held in Moscow in 2004 under the auspices of the NATO Programme Security through Science (NATO – Russia Joint Scientific and Technological Cooperation), on the theme "Disaster Forecast and Prevention", in which I participated. I was encouraged by the organizer of the meeting, Dr. Frederick Krimgold Director, Center for Disaster Risk Management, Virginia Tech., to apply to the NATO Office of Brussels, in my capacity of scientist of a NATO member country, for support required by the development of a project in this field. Soon thereafter, during a meeting held in Bucharest, hosted by Prof. Dorel Zugrvescu, Corresponding Member of the Romanian Academy, Director of the Institute of Geodynamics, Academician Alexandr Gliko, Director of the Institute of Physics of the Earth, Moscow, agreed to set up a joint project aimed to contribute to developments in the domain of quantification of seismic intensity. He nominated Prof. Felix Aptikaev, who was leading research activities in this field, as a counterpart on behalf of his institute. During subsequent contacts, it was agreed to invite the Institute of Geology and Seismology of Chisinu, Moldova (Director and counterpart: Dr. Vasile Alcaz), to join the project. The application forwarded to the NATO Office was accepted and NATO provided the Collaborative Linkage Grant No. 981619 for the Project

Quantification of earthquake action on structures

The cooperative activities in this framework lasted from 2005 to 2008. They included meetings in Bucharest, Chisinau and Moscow and led to the drafting of some joint papers. The main participants in these activities were the authors of this volume. Finally, the NATO Office agreed to provide support for the publication of the volume.

2. PAPERS INCLUDED IN THE VOLUME

The volume includes following papers (the papers P.1 to P.8 reproduced from previous publications; the papers P.9 to P.12 newly drafted) on which some comments are due:

P.1. Sandi, H., Floricel, I., *Some alternative instrumental measures of ground motion severity*, Proc. 11-th European Conf. on Earthquake Engineering, Paris, 1998

P.2. Aptikaev, F., *Instrumental seismic intensity scale*, Proc. Symposium on the 40-th anniversary of IZIIS, Skopje, 2005

P.3. Aptikaev, F. (editor), *Project of Russian Seismic Intensity Scale RIS-04*, Proc. First European Conf. on Earthquake Engineering and Seismology, Geneva, Switzerland, (Paper No. 1291), 2006

P.4. Sandi, H., *Bridging a gap between seismologists and engineers: possible restructuring of the intensity scale(s)*, Proc. First European Conf. on Earthquake Engineering and Seismology, Geneva, Switzerland, (Paper No. 571), 2006

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P.10. Alcaz, V, Borcia, I. S., Sandi, H., *Some data and results concerning ground motion in Moldova during recent strong earthquakes of 1986 and 1990*

P.11. Borcia, I. S., Sandi, H., Aptikaev, F., Erteleva, O., Alcaz V., *Some statistical results related to the correlation of macroseismic estimates with instrumental estimates of seismic intensity*

P.12. Sandi, H., Borcia, I. S., *A major reason to fundamentally revise the traditional concept of macroseismic intensity: to avoid possible zonation mistakes. An illustrative case*

3. SOME REFERENCES TO THE ACTIVITIES OF RUSSIAN SEISMOLOGISTS

One of the main starting points of the activities carried out in the project framework was represented by recent seismological research of Russia, in which considerable attention was given to the use of instrumental information. Numerous seismic intensity scales were developed and proposed along time by various authors. The scales discussed at this place pertain to the "Mercalli family", as referred to in P.3 [Aptikaev & al., 2006]. Out of them, two scales, which were successively endorsed by the European Seismological Commission, are considered here as a reference to scales of this family, which rely, at least mainly if not exclusively, on visual observation or on oral information, gathered during post – earthquake surveys: the scales MSK-64. updated in 1977 [Medvedev, 1977], and EMS-98 [Grünthal, 1998].

The developments of P.7 [Aptikaev & al., 2008] refer, among other, to following ranking system (of increasing relevance) of the scales pertaining to this family:

- nominal scales;
- class scales;
- ordinal scales,
- interval scales;
- ratio (or absolute) scales.

While stating that the magnitude scale is an absolute scale, it is concluded in that paper that "The seismic scales of the Mercalli family are in the class of interval scales".

My comments:

- the rich and valuable results of P.2 [Aptikaev, 2005] concerning the distributions of several kinematic parameters of instrumental data recoded during earthquakes create a background for re-ranking (at least gradually) the seismic intensity scale to a ratio scale;
- the papers P.2, P.3 and P.7, together with their lists of references, convincingly illustrate the long term and valuable scientific work of the Russian school of seismology, that has brought numerous contributions of fundamental scientific importance in this field.

4. SOME REFERENCES TO ACTIVITIES IN ROMANIA

Another starting point of the project activities was represented by the scientific impact of the destructive Vrancea earthquake of 1977.03.04. The in depth post - earthquake survey initiated led to the development of statistical damage spectra [Bălan & al., 1982] for various reference areas of the City of Bucharest. The results obtained made it clear that in depth analyses of the features of earthquake ground motion deserve to be carried out in the frame of post – earthquake surveys. Earlier models on how to *quantify seismic intensity on the basis of instrumental records* were provided by publications of earthquake engineering experts, like

[Arias, 1970] and [Housner, 1970]. This stimulated analytical and numerical research carried out initially in the frame of INCERC [National Building Research Institute, Bucharest]. The outcome of this work was summarized first by the developments of P.1 [Sandi & Floricel, 1998] and by the overview Table 2 of P.8 [Aptikaev & al., 2008]. The system developed is flexible, making it possible to quantify the intensity according to needs, in global terms or, in a more detailed manner, in spectral and/or directional terms.

The last paper of this volume, P.12 [Sandi & Borcia, 2010], illustrates through a dramatic case study the errors and consequences that may be caused by the shortcomings of the use of scales of the Mercalli family.

In case one looks back at the ranking system reproduced from P.7 [Aptikaev & al., 2008], one may state that this system of intensity quantification pertains at least to the last class, namely that of absolute scales. On the other hand, one may state that the system exceeds the classes listed, since it introduces a *new way of multi-dimensional quantification of ground motion severity*, richly illustrated by the intensity spectra presented in P.9 [Borcia & Sandi, 2010].

5. COMMENTS ON THE INSTRUMENTAL INFORMATION AND ON ITS USE

The progress in the field of acquisition of data during earthquake occurrence is well known. Firstly, accelerographs were gradually improved, reaching at present the stage of digital data acquisition, with all the potential advantages derived. Secondly, the accelerographic networks gradually extended, reaching a stage in which, for some areas, the territory is quite well covered, in which some dense arrays are working, in which an increasing number of structures became well equipped. Given the advantages of instrumental information, of complete characterization of seismic motion at recording sites, of accuracy and certainty, making use of instrumental becomes compulsory from the scientific point of view. And yet, the most recently endorsed intensity scale, EMS-98 [Grünthal, 1998], *makes no use of instrumental information*. In the comments added to that scale, it is recognized that a good record fully characterizes the seismic motion at the recording site, but, since no working criterion is widely accepted in literature in order to quantify seismic intensity, the solution adopted was to skip the problem. Consequently, the assessment of intensity may be related no longer to a desired site, but to an area for which a kind of homogeneity of ground motion is implicitly assumed, and for which the intensity estimate has a kind of statistical sense. Therefore, the available techniques of gathering information that are accessible, influenced the definition of the object of investigation itself.

The group of the Institute of Physics of the Earth of Moscow, involved in the project, undertook a sustained work in order to check (and, following the results obtained) to recalibrate the parameters of ground motion used for intensity assessment, as shown in P.2 [Aptikaev, 2005]. The parameters considered were the (absolute) peak values of ground acceleration, ground velocity, ground displacement and (kinematic) power. It turned out that the ratios of geometric progressions are no longer the same as used in the frame of the MSK scale, where the unique value 2.0 had been assumed.

The group of Bucharest proceeded in a different (but compatible) way. A system of new kinematic criteria was postulated and calibrated. This means that the ground motion intensity has been radically redefined, P.1 [Sandi & Floricel, 1998], and this was done in a way that had to cover (and actually did), the technical needs of engineers involved in the earthquake protection of structures. More precisely, perhaps the most important achievement consisted of the fact that the system of definitions adopted made it possible to deal not only with *global intensities*, but also with newly introduced concepts, like that of *intensity spectra*.

6. CLOSURE

The gap existing between the ways of quantification of seismic ground motion intensity used in the frame of scales on one hand and the needs of detailing and accuracy that are proper to engineering earthquake protection activities on the other hand led to a situation in which many engineers are no longer interested in the concept of seismic intensity.

This is unfortunate for the activities carried out in both the fields of seismology and of earthquake engineering as well. The time has arrived to bridge this gap.

Given the stake raised by the development of the concept of seismic intensity and by the corresponding adaptation of post-earthquake survey techniques, as well as by the other functions of the concept of seismic intensity, a Joint Working Group (JWG), or Joint Task Group (JTG), in which the sub-groups of seismologists and engineers should be quite equal in size and in influence, should be established by the European Seismological Commission and by the European Association of Earthquake Engineering, in order to support progress in this field.

ACKNOWLEDGEMENTS

I am glad and honoured to acknowledge the support provided by the NATO Office of Brussels and by the following institutions:

- the Institute of Geodynamics of the Romanian Academy, Bucharest, the Academy of Technical Sciences of Romania and INCERC (the National Building Research Institute, Bucharest) in Romania;

- the Institute of Physics of the Earth of the Russian Academy of Sciences, Moscow, in Russia;

- the Institute of Geology and Seismology of the Moldavian Academy of Sciences, Chisinau, in the Republic of Moldova.

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ANNEX III

CORRESPONDENCE
RELATED TO THE SUBMISSION OF THE PROPOSAL

From: “Horea Sandi” <horeasandi@yahoo.com>
To: <ansal@boun.edu.tr>; <mgarcia@mncn.csic.es>
Cc: <martin.koller@resonance.ch>; <robin.spence@carltd.com>;
<garevski@pluto.iziis.ukim.edu.mk>; <Mauro.Dolce@protezionecivile.it>;
<eisenberg@seismo.ru>; <ajkap@civil.auth.gr>; <dslejko@ogs.trieste.it>;
<pgulkan@ce.metu.edu.tr>; <gottfried.gruenthal@gfz-potsdam.de>;
<rmwm@bgs.ac.uk>; <SCHWARZ@bauing.uni-weimar.de>; <afps@enpc.fr>;
<acdiaconu@yahoo.com>; <felix@ifz.ru>; <ertel@ifz.ru>; <alcazv@yahoo.com>;
<vladi@itcnet.ro>; <vlad@dial.kappa.ro>; <vradu@utcb.ro>; <mircea@infp.ro>;
<ssever@incerc2004.ro>; <isborcia@incerc2004.ro>
Subject: Proposal for a Joint, ESC-EAEE, Working Group
Date: Tuesday, August 17, 2010 2:47 PM

To:
Prof. Atilla Ansal, Secretary General, EAEE
Dr. Mariano García-Fernández, Secretary General, ESC

Cc:
Prof. Martin KOLLER, President, EAEE
Prof. Robin SPENCE, Vice - President, EAEE

Prof. Mihail GAREVSKI, Vice - President, EAEE
Prof. Mauro DOLCE, Executive Committee Member, EAEE
Prof. Jakob EISENBERG, Executive Committee Member, EAEE
Prof. Andreas J. KAPPOS, Executive Committee Member, EAEE
Prof. Dario SLEJKO, Representative of ESC, Executive Committee, EAEE
Prof. Polat GÜLKAN, President, IAEE
Dr. Gottfried GRÜNTHAL, Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences
Dr. Roger MUSSON, British Geological Survey, Edinburgh
Dr. Jochen SCHWARZ, Bauhaus – Universität,, Weimar
Prof. Philippe BISCH, President, AFPS
Prof. Pierre – Yves BARD, Vice - President, AFPS
Prof. Victor DAVIDOVICI, Honorary President, AFPS
Prof. Daniel DIACONU, President, ARIS
Prof. Felix APTIKAEV, Institute of Physics of the Earth, Moscow
Dr. Olga ERTELEVA, Institute of Physics of the Earth, Moscow
Dr. Vasile ALCAZ, Institute of Geology and Seismology, ChiĹźinÄu
Prof. Ion VLAD, Technical University of Civil Engineering, Bucharest
Prof. Radu VĂCĂREANU, Technical University of Civil Engineering, Bucharest
Dr. Mircea RADULIAN, national representative of Romania to ESC
Dr. Emil Sever GEORGESCU, national representative of Romania to EAEE
Dr. Ioan Sorin BORCIA, Building Research Institute, Bucharest

Dear colleagues,

Following the suggestions by Prof. Martin Koller, Prof. Robin Spence and Dr. Mariano García-Fernández, reproduced below, in reaction to my previous circular message, also reproduced, I am sending you attached a proposal to form a Joint ESC-EAEE Working Group on

UPDATING OF THE CONCEPT OF SEISMIC INTENSITY AND OF THE INTENSITY SCALES
together with an illustrative Annex.

Best regards,
Horea Sandi
****

—— Forwarded Message ——
From: Mariano Garcia Fernandez
To: Horea Sandi <horeasandi@yahoo.com>
Cc: ansal@boun.edu.tr; mircea@infp.ro; Ioan Sorin Borcia <isborcia@incerc2004.ro>; Horea Sandi <sandi@geodin.ro>; Felix Aptikaev <felix@ifz.ru>; Vasile Alcaz <alcazv@yahoo.com>
Sent: Fri, August 6, 2010 3:28:47 PM
Subject: Re: Fw: Thank you!

Dear Prof. Sandi,

Thanks for your message and for the copy of your book (I will let you know when I receive it).

I encourage you to send the proposal for a joint EAEE-ESC task-working group, following the recommendations by Robin and Martin. Attached is a summary of the requirements for a ESC working group.

With kindest regards,
Mariano
****

At 05/08/2010 15:32, Horea Sandi wrote:

Dr. Mariano Garcia-Fernandez , Inst. of Earth Sciences “Jaume Almeria”, Secretary General, ESC.

Dear Dr. Garcia,

I am forwarding you below a circular lettter sent initially to some of the members of the Executive Committee of EAEE.

Following the suggestions of the President and of the Vice Presidents of EAEE, I am sending you below also their first reactions, which involved, first, informing you on this subject.

I would like to mention that I shall come up soon with a second message, to present some proposals to the Executive Committee of EAEE, in connection with the Ohrid Conference.

Meanwhile, I am glad to inform you that a copy of the volume referred to has been sent to you today by regular mail.

Best regards, Horea Sandi.
****

—— Forwarded Message ——
From: Robin Spence <robin.spence@carltd.com>
To: Martin Koller <martin.koller@resonance.ch>
Cc: Horea Sandi <horeasandi@yahoo.com>; Atilla Ansal <ansal@boun.edu.tr>; “Garevski, Mihail” <garevski@pluto.iziis.ukim.edu.mk>; Robin Spence <robin@carltd.com>
Sent: Tue, July 27, 2010 4:53:37 PM
Subject: Re: Sending a volume

Dear Horea, Martin, Atilla and colleagues

Thanks Horea for this initiatve. I certainly think it would be valuable to discuss this idea of a joint ESC/EAEE working group on seismic intensity scales and damage assessment within the context of continuing EAEE Working Groups. A number of important issues have arisen in recent damage assessment surveys, including Haiti, and the issue of how to define a damage scale which can be useful for damage assessments using aerial and satellite images is one relevant question.
However, Horea’s paper does not propose a set of aims for the working group, which I think should be a minimum starting point for the ExCo to have a useful discussion. Can I request Horea, that you have a go at putting together a draft set of aims before the Ohrid meeting ?
Many thanks
Robin Spence
****

Martin Koller wrote:

Dear Prof. Sandi,

Thank you for your interesting initiative. We shall discuss it at our next executive committee meeting in Ohrid, during the 14th ECEE.
Best regards.
Martin Koller
President of EAEE
****

—— Forwarded Message ——
From: Martin Koller <martin.koller@resonance.ch>
To: Horea Sandi <horeasandi@yahoo.com>
Sent: Tue, July 27, 2010 3:39:40 PM
Subject: Thank you!

Dear Prof. Sandi,

Your book “Quantification of Seismic Action on Structures” has arrived today. Thank you very much! I shall try to go through the main articles about a new intensity scale before the Ohrid conference.

If you suggest a new task group, you should submit to Atilla (EAEE) and Mariano (ESC) a proposal of 1 - 2 pages with good arguments as well as, perhaps, a suggestion for members of this task group.

Best regards.
Martin Koller

Martin G. Koller
Résonance Ingénieurs-Conseils SA
21 rue Jacques Grosselin
1227 Carouge (GE)
Switzerland
Tel: (+41) 22 301 02 53
Fax: (+41) 22 301 02 70
E-mail:
martin.koller@resonance.ch
Site web: www.resonance.ch
****

Le 21.07.2010 09:14, Horea Sandi a écrit :

To:
Prof. Polat GÜLKAN, President, IAEE
Prof. Martin KOLLER, President, EAEE
Prof. Robin SPENCE, Vice - President, EAEE
Prof. Mihail GAREVSKI, Vice - President, EAEE
Prof. Atilla ANSAL, Secretary General, EAEE
Prof. Mauro DOLCE, Executive Committee Member, EAEE
Prof. Jakob EISENBERG, Executive Committee Member, EAEE
Prof. Andreas J. KAPPOS, Executive Committee Member, EAEE
Prof. Dario SLEJKO, Representative of ESC, Executive Committee,EAEE
Dr. Gottfried GRÜNTHAL, Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences
Dr. Roger MUSSON, British Geological Survey, Edinburgh
Dr. Jochen SCHWARZ, Bauhaus – Universität,, Weimar
Prof. Philippe BISCH, President, AFPS
Prof. Pierre – Yvves BARD, Vice - President, AFPS
Prof. Victor DAVIDOVICI, Honorary President, AFPS
Prof. Daniel DIACONU, President, ARIS

Cc :
Prof. Felix APTIKAEV, Institute of Physics of the Earth, Moscow
Dr. Olga ERTELEVA, Institute of Physics of the Earth, Moscow
Dr. Vasile ALCAZ, Institute of Geology and Seismology, ChiĹźinÄu
Prof. Ion VLAD, Technical University of Civil Engineering, Bucharest
Prof. Radu VĂCĂREANU, Technical University of Civil Engineering,Bucharest

Dr. Mircea RADULIAN, national representative of Romania to ESC
Dr. Emil Sever GEORGESCU, national representative of Romania to EAEE
Dr. Ioan Sorin BORCIA, Building Research Institute, Bucharest

Dear colleagues,

I take the pleasure to inform you that you will receive soon, by regular mail, the volume

"Quantification of Seismic Action on Structures",

by H. Sandi, F. Aptikaev, I. S: Borcia, O. Erteleva & V. Alcaz, published recently by the AGIR Publishing House, Bucharest.

The volume is devoted basically to studies related to a project aimed at updating the concept of seismic intensity. The frame in which the volume was drafted is briefly presented in its foreword, which is attached to this message too.

According to my understanding, the traditional view of this concept, as reflected by the MSK and EMS scales, which were successively endorsed by the ESC, corresponds to a quite early stage of know-how on earthquake action and its effects. A comparison with the state of the art of current engineering approaches reveals a huge gap, such that the traditional concept of intensity is of questionable interest for engineering activities. I think that this gap can be gradually bridged and that would be a desirable outcome for seismologists and engineers both. The volume presents some attempts in this sense.

I also believe that there is highest time for engineers to engage in an attempt of developing of a more appropriate intensity scale and that EAEE should contact soon ESC in order to build a Joint Task Group on this subject. I think also that it is important to provide the engineers a position to match the position of seismologists in such a frame. The forthcoming14-th ECEE could provide a frame for a first debate on this subject.

Best regards,
Horea Sandi,
President, Division of Civil Engineering,
Academy of Technical Sciences of Romania.