UDK 699.88

ANALYSIS OF WORLD EXPERIENCE IN THE FIELD OF RAPID VISUAL SCREEN

O.Murashko,*ph.D, associate prof.,* **Ilham Benradi,** *bachelor*

Odessa State Academy Of Civil Engineering And Architecture

INTRODUCTION

Rapid Visual Screening (RVS) or Rapid Screening Procedure (RSP) is intended for recognizing potential-dangerous buildings in the particular field, without performing detailed examination or involving structural computations. This method utilizes a scoring system to identify the main structural system related to lateral load-resisting mechanism (FEMA, 1988a). Building elements that change the seismic performance is also considered as modifying factor for the final score. All evaluation started from collecting information to giving decision are done at the building site in short time.

The RVS procedure was prepared for a wide-ranging user starting from building officials to private-sector such as building owners to decide which are expected to have adequate seismic performance and which are decided seismically dangerous and should be examined more in detail.

The aim of the RVS procedure is generally to examine seismic vulnerability level of a buildings population based on the cut-off rate as a level either have accepted or my hazardous and should be studied further in detail. Some methodologies had been proposed based on earthquake data or analytical approaches. A method developed in US by FEMA (FEMA 154) is well known and became a main reference for application in some countries outside US by some modifications.

Ukrainian RVS system now is currently being developedas part of three tiered system of Actual Seismic Resistance assessment [8],[9],[10]/

Study objective – to compare foreign RVS methods for main criterias reveal

To achieve this objective in this paper next systems were analized Fema 154,Turkish RVS, Switzerland RVS, New Zealand RVS and Indian RVS

FEMA 154 (USA)

A procedure for rapid visual screening (RVS) was first proposed by Federal Emergency Management Agency in FEMA-154 on 1988 for identifying, recording, and ranking buildings that are probably seismically dangerous in the US (FEMA, 1988a) which was further modified in 2002

[1] to facilitated new technological improvement and also experience-lessons from previous earthquake hazards (1990s). RVS procedure has been broadly used in many other countries after some adaptations related to the local condition.

FEMA RVS utilizes a methodology which is started with examining the main structural system and the use of materials in the building with a score based on basic structural hazard (BSH), and modifying by optional condition in the building which will modify the score (as PMFs or performance modification factors).2.11.2 Basic Structural Hazard (BSH)Structural hazard score is a measure of the probability of major seismic damage to the building. Major damage is taken to be direct physical damage being 60% or greater of the building value in FEMA 155 / ATC 13-1985 (FEMA, 1988b). The determination of the Basic Structural Hazard score is

Basic Structural Hazard Score= -log (probability of damage >= 60%).

If the probability of damage exceeding 60%, given value for the building site, is, for example, .001, then the Basic Structural Hazard score is 3. If the probability is .01, then it is 2, so on. The final score as structural score‗‘ is calculation (subtraction) of basic score (defined by main system and material) and modification aspect found as PMFs.

S (Structural score) = BSH (Basic Structural Hazard) + PMFs (Performance Modification Factor)

FEMA-RVS scores range from 0 – 4 which are based on logarithmic calculation explained above. Low S‘ score means that the building is vulnerable and needs for further detailed analysis. Oppositely, a high S‘ score shows that the building is probably safe for earthquake threat. FEMA 154 suggested for cutoff value is typically as 2.0, which means 1 percent chance of collapse at ground shaking ―two thirds of the 2% probability of exceedance in 50-year peak ground accelerations for the seismicity region of the county in which the building is located.

TURKISH RVS:

The Turkish RVS procedure was originally developed by Sucuoglu, H. and Yazgan, U. (2003),[5] which uses a two-level seismic risk assessment method for low to mid rise less than 8 stories with regular reinforced concrete buildings. A data of 477 damaged buildings surveyed after the 1999 Düzee earthquake had been utilized for the procedure which was on the basis of statistical correlations. The first survey level is conducted from the sidewalk by trained observers through walk-down visits and extended by structural parameters measured by entering into the ground storey in the second level. The acquired data is then processed for calculating a risk score for each building.

This method has some similarities with FEMA RVS in FEMA-154 (FEMA, 1988a) except the grading method they used. Because it was believed that most residential building do not match to the necessities of modern seismic design and construction rules, Turkish-RVS method is proposed to provide a more report of seismic risk for the mid storey buildings constructed by reinforced concrete in Turkey. The damage enlarges almost linearly with the number of stories.

The seismic performance score PS is calculation of the base scores (TP), the Penalty score multiplier (Oi), and the Penalty score for vulnerability parameter (Opi) using equation, and (OP) Positive score:

$$PS=TP + \sum Oi*Opi+ OP$$

PS: Performance score;

TP: Base score;

O_i: Penalty score multiplier;

O_{pi}: Penalty score for vulnerability parameter;

OP: Positive score;

INDIAN RVS

The assessment proposed by SERC Report (Structural Engineering Research Center) using a rapid assessment method level 1 as a customized FEMA 154 method considered the Indian situation. The detailed Level 2 Structural Analysis is proceed out if the grading method used is if the accumulated structural score is higher than 1. The method is very similar to FEMA 310–Tier 1 technique (Rai, D.C.).Sinha, R and Goyal, A, (2004) proposed RVS in India by dividing the buildings into the categories[4]: masonry buildings, RC buildings, steel buildings, and timber buildings. Based on the seismic resistance the vulnerability categorization has been proposed refer to the European Macro-seismic Scale (EMS-98) which defines building damage to be in Grade 1 to Grade 5,[6] .

INITIAL EVALUATION PROCEDURE IN NEW ZEALAND

The NZSEE recommends a two-stage evaluation process. The initial evaluation procedure (IEP) is intended to be a coarse screening involving as few resources as reasonably possible. It is expected that the IEP will be followed by a more detailed assessment for those buildings identified in the evaluation as likely to be Earthquake Prone (EPB) in terms of the provisions of the NZ Building Act 2004,[7].

Key elements of the procedures are:

1. an initial evaluation (refer to this Section 3)
2. a detailed assessment for buildings not passing the initial evaluation (refer to Section 4)
3. a requirement to improve the structural performance of buildings

failing the detailed evaluation (refer to Section 5)

4. provision for an optional earthquake risk grading for all buildings (refer to Section 3.3 below).

This Section 3 of the NZSEE Guidelines describes the Initial Evaluation Procedure (IEP)[3]. Procedures for the detailed evaluation and guidelines for the improvement of structural performance are given in Sections 4 and 5 respectively.

Note that the objective of the initial evaluation is to identify, with an acceptable confidence level, all those buildings which will be potentially Earthquake Prone. At the same time the initial evaluation process must not catch an unacceptable number of buildings which on detailed evaluation, pass the test.

INITIAL EVALUATION PROCEDURE IN SWITZERLAND

The seismic hazard has long been underestimated in Switzerland. Therefore the sensitivity of the structures to earthquakes was considered late in the standards of the Swiss Society of Engineers and Architects (SIA) and therefore by construction environments. Published in 1970, the standard SIA 160 Norm Belastungsannahmen für die, die die Überwachung Inbetriebnahme und der Bauten for the first time included the seismic provisions and introduced in the form of a horizontal and independent replacement effort of frequency, rules helping to design the works according to earthquakes. The danger they cause is deepened in SIA 160 Actions supporting structures [2], published in 1989, which gives it more room. It is considered that the provisions of this standard throw good basis for designing new buildings taking into account earthquakes.

According to the Federal Council decision of 11 December 2000, positions responsible for the federal government are responsible for verifying the seismic safety of all book class II and III buildings of Confederation, and all projects consolidation or transformation works or Confederation facilities. In the presence of critical gaps, these structures must be strengthened, taking into account the proportionality of costs. The Federal Office for Water and Geology has to do what a concept developed and applied to three-step procedure.

In step 1, the important features of the building are identified with architectural plans and a possible visit. The seismic risk is then drawn crudely on the basis of a checklist (approx. 4 hours per building).

Risk estimation does not require detailed calculations, but also issues no absolute discretion. Priorities for further analysis are defined on the basis of a risk index and an index of probability of collapse.

There are also steps 2 and 3 which devoted to the further seismic resistance estimation. They implements if the deficit of resistance was

In Table 1 described major factors that significantly impact on structural performance during earthquakes, and the assignment of Score Modifiers related to each of these factors (attributes) for each of the methods.

Table 1. Comparisson of RVS systems

Factors	New Zealand Standard	Switzerland Standard	India Rapid Screening Process (RSP)	Turkish	FEMA
1	2	3	4	5	6
the Basic Structural Hazard Score	+ %NBS : Percentage of new building standard	+ AZPS : extent of injury and property damage	+ BSH	the Basic Structural Hazard Score	+ BSH the Basic Structural Hazard Score
probability of collapse of the building	-	+ WZ : probability indicator of collapse of the structure	+	-	+ MCE : probability of collapse of the building
Building type(s)	+	+	+	+	+
Near Fault scaling factor	A	-	-	-	-
Hazard scaling factor	B	-	-	-	-
Return Period scaling factor	C	+	+	+	+
Form Of construction, ductility	+ D : Ductility scaling factor	+ WD	-	-	-

Table 1 continued

1	2	3	4	5	6
Structural Performance scaling factor	+	+	-	-	-

site effect	-	+ WB	-	-	-
bracing plan	-	+ WG	-	-	-
Bracing and shape of the building elevation	-	+ WA	-	-	-
bracing quality	-	+ WW	-	-	-
outline of the structure	-	+ WK	-	-	-
Soil type	+	+ WF	+	+	+
performance achievement ratio	+ (PAR)	-	-	-	-
Region of Seismicity	+	+	+	+	+
Historic Significance	-	-	-	-	+
Type of structural system--	+	+	-	+	+ Structural system description
The number of unrestrained (free) stories (ns)	-	-	-	+	-
Short column	-	-	+	+	-
Apparent quality and existing condition	-	-	-	+	-
Topographic effect	-	-	-	+	-
Vertical irregularity	+	-	+	+	-
Heavy overhangs	-	-	-	+	-
Irregularity in plan torsion:	+	+	+	+	-
Building adjacency/pounding	-	-	+	+	-
General building description	-	-	-	-	+

Table 1 continued

1	2	3	4	5	6
Nonstructural element description	-	-	-	-	+

Building Occupancy	-	-	-	-	+
Soft story	-	-	+	+	-

Conclusions

1.According to a detailed comparison of the seismic evaluation of buildings for potential seismic hazards in each of the proposed methods we conclud that common parameters between these methods are :

- Basic Structural Hazard Score
- Probability of collapse of the building
- Return Period scaling factor
- Building type (s)
- Return Period scaling factor
- Soil type
- Vertical irregularity
- Irregularity in plan:

2. Based on these results will be performed the second stage of studies, which based on the use of the theory of mathematically planned experiment and explores the influence of each factor for the creation of the Ukrainian system RVS.

Summary

This study is a review of world's experience inRapid Visual Screening systems for assessment seismic resistance of buildings. This work aims to compare other countries assessment systems and to provide criteria for the developing Ukrainian Assessment systems.

Reference

1-Rapid Visual Screening of Buildings for PotentialSeismic Hazards A Handbook FEMA 154, Edition 2 / March 2002 .

2-Vérification de la sécurité parasismique des bâtiments existants Concept et directives pour l'étape 1 Richtlinien des BWG – Directives de l'OFEG – Dirretive dell'UFAEG Berne, 2005 Deuxième édition.

3- Assessment and Improvement of the Structural Performance ofBuildings in Earthquakes Prioritisation Initial Evaluation Detailed Assessment Improvement Measures Recommendations of a NZSEE Study Group on Earthquake Risk Buildings June 2006 Including Corregendum No. 1

4- Handbook on seismic retrofit of buildings (April 2007) central public works department&indian building congress in association with indian institute of technology – madras.

5. Yakut, A., Aydogan, V., Ozcebe, G., and Yucement , M .S., " Preliminary seismic vulnerability assessment of existing reinforced concrete buildings in Turkey – Part II ". Nato Science Series. IV/29, pp 43-58, May 2005.

6. ICS 91. 120.25 Indian standard :Criteria for earthquake design of structures http://fr.slideshare.net/asifzhcet/1893-2002-part-1

7. NZS 1170.5-2004. Earthquake actions - New Zealandhttp://wenku.baidu.com/view/67b025681eb91a37f1115cf3.html

8.O. Murashko, O. Adamov., "A New Approach To The Dynamic Certification In Ukraine", Proceedings of the 5th International Conference of Young Scientists GEODESY, ARCHITECTURE & CONSTRUCTION, November 21–23, 2013, Lviv, Ukraine, pp112-113

9.V.Dorofeev, K.Yegupov, A.Murashko, O.Adamov "A new approach to buildings seismic resistance assessment in Ukraine", Proceedings of the 2-nd European Conference on Earthquake Engineering and Seismology, August 24-29, 2014, Istambul, Turkey pp. 138-143

10. V. Dorofeev, K.Yegupov, O.Murashko, D.Bezushko "Numerical modeling of multistory confined masonry structures in seismic regions of Ukraine" Proceedings of the The Eights International Conference on Material Technologies and Modeling , July 28 - August 01 2014, Ariel, Israel - ISBN: 978-965-91944-2-1