Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 139 (2017) 385–390

Energy Procedia

www.elsevier.com/locate/procedia

International Conference On Materials And Energy 2015, ICOME 15, 19-22 May 2015, Tetouan, Morocco, and the International Conference On Materials And Energy 2016, ICOME 16, 17-20 May 2016, La Rochelle, France

Rehabilitation Study of Construction Built in Seismic Zone on Algeria

Imane Djafar Henni [a]*, Amar Kassoul[a]

[a] *Laboratory of Structures, Geotechnics and Risks (LSGR), Faculty of Civil Engineering and Architecture, Hassiba Benbouali University of Chlef, Hay Es Salam, B.P 151, Chlef 02000, Algeria*

Abstract

The rehabilitation of damaged buildings is a domain which remains a challenge after each earthquake. From there, several studies have been launched in this domain. The objective of this work is to achieve a rehabilitation study of an administrative building built in a low seismicity zone according to the old Algerian earthquake rules (RPA83). Moreover, after the earthquake of Boumerdes in 2003, modifications have been made to this regulation, and this zone was changed into a high seismicity zone. However, after diagnosis and various investigations, it is always hard to make a radical choice about the preferred method of rehabilitation, for this, a comparative study of the rehabilitation of the building will be performed by proposing two models of bracing members, knowing that the first model concerns the strengthening by adding new reinforced concrete shear walls and the second is about the integration of new steel braced frames. Finally, we will highlight the performance of the proposed solutions for the strengthening by nonlinear static analysis. The results obtained in terms of capacity curve and performance point showed a large performance of the structure by the two proposed reinforcing models.

Peer-review under responsibility of the scientific committee of ICOME 2015 and ICOME 2016.

Keywords: Rehabilitation, Vulnerability, Shear wall,Steel bracing, Pushover Analysis

1. Introduction

Many existing buildings in Algeria, built according to the old codes, do not possess the necessary seismic resistance, and can seriously compromise occupant safety during a moderate seismic event. Losses due to

* Corresponding author. Tel.: +213 560 790 781
E-mail address: i.djafarhenni@univhb-chlef.dz

1876-6102
Peer-review under responsibility of the scientific committee of ICOME 2015 and ICOME 2016
10.1016/j.egypro.2017.11.226

earthquakes are usually significant, but they can become gravest due to ignorance or the lack in the application of an efficient and integrated rehabilitation. In fact, precipitated or incorrect conception as well as poor execution of the repair works can lead to greater damages and even to loss of human life in case future quakes [1]. Numerous studies have been conducted on the rehabilitation of vulnerable structures. Hassaballah *et al.* [2] conducted a strengthening of weak columns of an existing hospital in Sudan by inserting reinforced concrete shear walls and the proposed solution has completely solved the problem and all columns were secured, And, this same technique was adopted by Kaltakci *et al.* [3], Yalciner and Hedayat [4] and Davidovici [5]. On the other hand, several configurations of bracing systems may be installed within the bays of a reinforced concrete frame aiming to provide a significant increase of the horizontal capacity of the structure, as have demonstrated Farmisano *et al.* [6], who have validated this reinforcement technique on an existing structure in Italy. In Algeria, several practical studies have been conducted on the rehabilitation of structures after El Asnam earthquake in 1980 and Boumerdes earthquake in 2003 [7]. Moreover, despite the existence of recommendations [8] and a technical guide of repair or strengthening methods for structures [9], there is a lack of regulatory support for the study of rehabilitation. The purpose of this study concerns the rehabilitation of an administrative building dimensioned according to the version of Algerian earthquake rules RPA81/v1983, which the bracing system is provided by the resisting frame systems, in a transitory period where the seismic code has not known its true application in low seismicity zones. Currently, this zone was changed to a high seismicity zone (zone IIb) in the present version of the Algerian earthquake rules (RPA99/v2003) [10]. First, a summary of the rehabilitation method of Eurocode 8-3 [11] is presented. Then two rehabilitation models are proposed for reinforcement. Finally, the paper highlights the performance of the proposed solutions for the reinforcement using the capacity spectrum method (CSM) applied according to the ATC40 code [12], which is a non-linear static analysis.

2. Method of rehabilitation according to the Eurocode 8-3

2.1. Information for structural assessment

According to the steps described by Eurocode 8-3 [11], the first step governing the structural rehabilitation begins with the collection of the general and historical information of the building, especially the required input data to begin the rehabilitation methodology.

2.2. Definition and identification of knowledge levels

The type of allowable analysis and the appropriate confidence factor values, according to EC8-3 [11] is based on three knowledge levels, namely limited knowledge (KL1), normal (KL2) and full (KL3).

2.3. Confidence factors

To determine the properties of existing materials used in the calculation of capacity, and when this one must be compared with demand for safety verification, the average values obtained from in-situ tests and the additional sources of information shall be divided by the coefficient of confidence, CF, given by the EC8-3 [11], which is the appropriate knowledge level that complies with the requirements.

2.4. Vulnerability assessment:

Assessment is a quantitative procedure for checking whether an existing undamaged or damaged building will satisfy the required limit state appropriate to the seismic action under consideration, as specified in EC8-1 [11].

2.5. Decisions for structural intervention

On the basis of the conclusions of the assessment of the structure, of the nature and extent of the damage, decisions should be taken for the intervention, following the technical aspects of the relevant criteria to the EC8-3