Optimization study design of a reinforced concrete building in the seismic critical region in Morocco

Taoufik TBATOU, Pr. Mohamed ROUGUI

Abstract— Earthquakes are a natural geological activity. They cause major destruction. The acquire means prevention is required to mitigate their adverse effects and impacts on humanity. One of these ways is the new generation of seismic codes including RPS 2011 in Morocco used to size the new structures and verify the vulnerability of existing action against earthquakes constructions.
This paper focuses on the discovery of the economic impact of the new progress of Moroccan seismic regulations, using data acceleration and speed according to the seismic response spectrum in the two most critical areas of Morocco: Rif and Tanger regions. In recent years, these two areas have a very important step in the real estate sector, which in case of poor convergence of good design can be seriously affected and cause great losses.

Index Terms— Concrete, Displacement, RPS, Seismic, Sizing Building, Seismic area.

1 INTRODUCTION

In seismic codes or regulations, the study of the response of building structures to the effects of earthquakes is conducted to optimize the seismic design using simplified methods based on the response spectrum of structures. In addition, the method is to use a procedure for calculating maximum displacements of different levels of reinforced concrete building located on a ground reference type S1 [1], regular class II (RPS2000) [2], and III (RPS2011) [3], with a coefficient of importance 1.
In this paper, we propose an evaluation study of the parameter of economic arbitration on the impact of design according RPS2011 by a comparison between the new regulation 2011 earthquake and the other of 2000 at a level of seismic elastic response spectrum for damping relative ξ = 5% applied in two regions of northern Morocco on a website S1 (Rocher any depth), the first area is that of the Rif (Alhociema, Imzouren ...) according RPS2011 (v4 Zone), and the second region of the north (Tangier) which is classified area (ZV3) according RPS201, and both areas are classified Z3 according to RPS 2000.

2 SEISMIC ZONING

To estimate the seismic risk assessment and the design of building structures based on the concept of seismic zoning in Morocco and soil type, a very useful method allowed us to determine the maximum displacements. This method, called spectral method [4], using general concepts of the method of modal recombination.
To do this, we maintain the standards of seismic regulations for Moroccan soil type S1, such as the evaluation of the action of the earthquake in the same area and approximately the same level of seismic risk for a probability of occurrence of 10% in 50 years on a building structure which is made based on RPS 2000 RPS2011 where the behavior of the response of the building depends on the seismic zoning map indicated by factors such as acceleration and seismic velocity maximum ground reference (S1), with:

RPS2000: Amax = 0.16g for Zone 3 (Northern Regions: Tangier and the Rif).
RPS2011: taking into account the acceleration and seismic velocity (relative acceleration/ velocity):

Za / Zv = 1.058 for the area of the Rif
Za / Zv = 1.076 for the area of Tangier

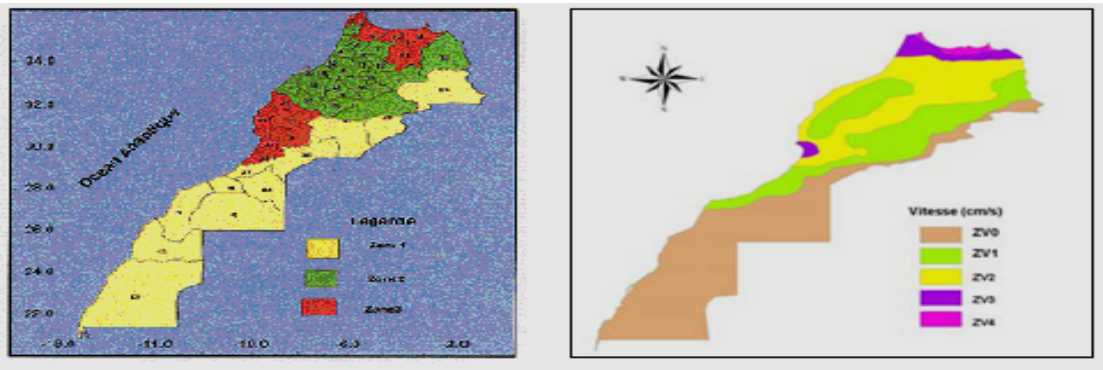


Fig 1. **Seismic zoning map of Morocco (RPS 2000) left and (RPS2011) right**

The index of stability:

The index of stability is represented by the equation:

RPS 2000: $\Theta = KW\,Del / V\,h$ (1)

$V = WASDI/K$ (2)

RPS 2011: $\Theta = KW\,Del / F\,h$ (3)

$F = WvSDI/K$ (4)

Θ	Stability index
W	Weight above the floor considered
V,F	Seismic actions at the level considered
h	Storey height
Del	Relative displacement
K	Behavior factor
A,v	Coefficient of acceleration and velocity zone
S	Coefficient of Site
D	Dynamic amplification factor given by the amplification spectrum
I	Coefficient given priority

3 APPLICATION

Description of the studied building:

The studied building is designed reinforced concrete [5] - [6], for residential use (Figure 2) consisted of a ground floor under four floors. Resistant structure is composed of solid slabs of thickness 12 cm, the main beams have a (25x45 cm²) section, while the poles have a (30x30 cm²) section, the building is located on a soil type S1. The concrete used has a strength of 25Mpa, HA500 steel, the reinforcement of beams and columns is (4.8 Φ12, 10 and 8). The building is a regular design (to avoid twisting effect) [7] and dimensioned according to the Moroccan seismic regulations.

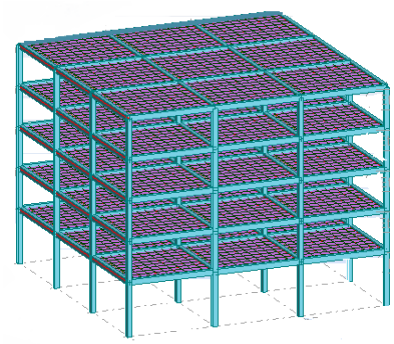


Fig 2 : Model of reinforced concrete building (R+4)

Designation	ground floor	Floor 1	Floor 2	Floor 3	Floor 4
height (m)	4	7	10	13	16

For spectrum analysis response the following cases were considered:

- Application of the gravity loads.
- Application of the lateral load in the XY direction.
- Application for Permanent and exploitation's loads.
- Lack of effect of the Soil-Structure interaction.

4 RESULT

To estimate the difference between RPS2000 and 2011 at sizing design reinforced concrete building by determining the seismic vulnerability of the building (the movement of the building' floors), an analysis of seismic simulation of two critical regions has been carried out by the software [8] with the application of the horizontal direction of the earthquake which is along the axis of X and Y with X = Y.

Eigenmodes:

our calculated is based on the first eight eigenmodes, to make it clear that the behavior of the response of the building.

eigenmodes	frequency [Hz]	period [s]	cumulative masses UX [%]	cumulative masses UY [%]
1	0,73	1,37	32,83	58,7
2	0,73	1,37	91,53	91,53
3	0,91	1,10	91,53	91,53
4	2,29	0,44	98,13	91,68
5	2,29	0,44	98,29	98,29
6	2,84	0,35	98,29	98,29
7	4,05	0,25	98,74	99,16
8	4,05	0,25	99,61	99,61

a- displacements:

The displacements of each height were prepared using [8] software.

Displacements calculated using the parameters RPS2011 building are lower than those calculated by RPS2000 for both critical areas of Morocco (most vulnerable to seismic response). These movements are classified as follows:

Displacement (v3 zone (Tanger)) < Displacement (v4 zone (Rif)) < Displacement (zone 3 (north))

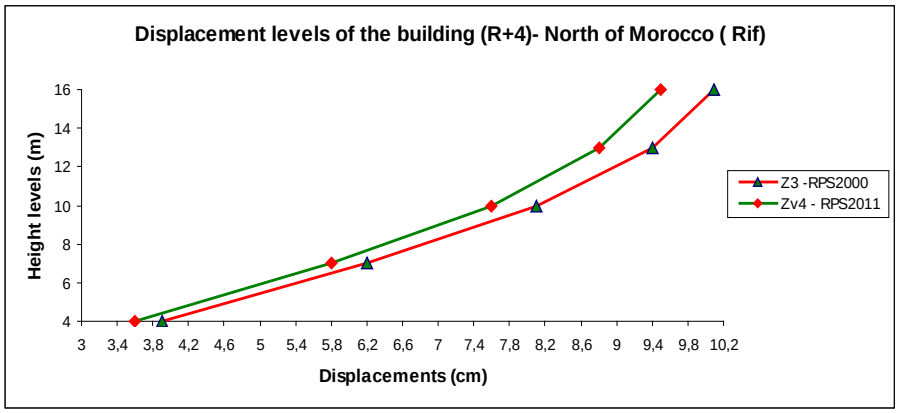


Fig 3. The maximum displacements of the floors of the building-Rif region of Morocco

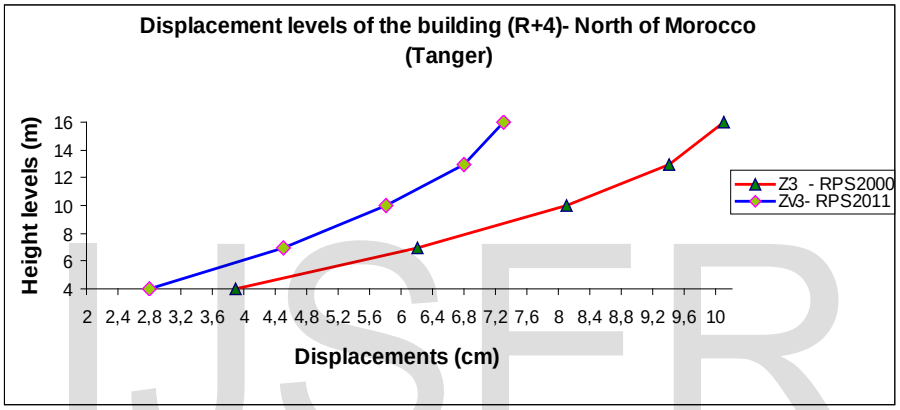


Fig 4. The maximum displacements of the floors of the building- Tangier Region of Morocco

- Rif region of Morocco -Al Hoceima - (Figure 3): Reduction of the displacements of the building's levels to 6 mm measured at the top roof of the building.
- Northern Morocco - Tangier – (Figure 4): Minimization of the displacements of the building's levels by 28 mm measured at the top roof of the building.

b- Interpretation :

The values of the index of stability of the structure:

Area	Zv3	Zv4	Z3
θ	0,097	0,084	0,081

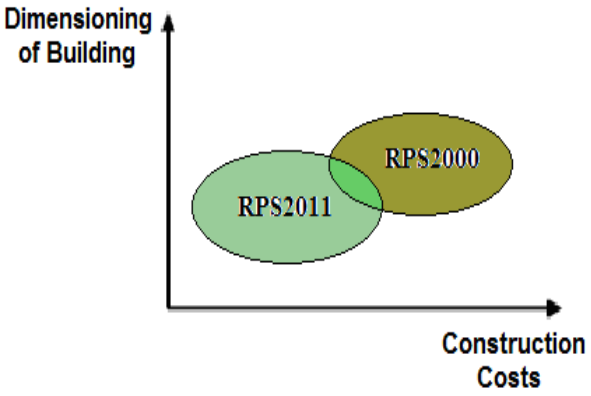
It is observed that the stability index calculated by RPS2011 is less that calculated by RPS2000 in the same region, the site (S1) and the structure, which shows that :
-The performance of the dimensionnement (less of the risk) of reinforced concrete building in this study by using RPS2011,
-RPS 2011 optimizes the displacement of reinforced concrete building compared to RPS2000:
Area (ZV4 Al Hoceima): Optimization of about 6 mm of displacement, which reduces the risk of this design to 5,9% by using RPS2011 relative to RPS2000 (gain of sizing).
Area (ZV3 Tangier): Optimizing 28 mm of displacement, which allows to reduces the risk of this design to about 27,72% by using RPS2011 relative to RPS2000 (optimization of sizing).

5 Conclusion

We notice that the new Regulations of Moroccan Earthquake Construction (2011) has more of the following three traditional and fundamental objectives:

1- Public safety during an earthquake.
2- Continuity of basic services.
3- The protection of property.

One objective of the new code (2011) consists of minimizing construction costs by optimizing design of the building using the convergence of the exact description of the seismic zoning in Morocco and the determination of the behavior of the maximum seismic response reinforced concrete building, which is required by the competition and the development of other international seismic regulations.



In perspective we hope that all the engineering offices follow the new RPS2011 in order to optimize the cost of construction of new buildings and those to be strengthened.

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