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Behavior of masonry walls with respect to Seismic stress, analysis and recommendation

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ABSTRACT

Structures with masonry infill panels and reinforced concrete frame are widely used structural systems and by lack of knowledge considered secondary, masonry infill walls are considered until now as non-load-bearing elements, therefore the role of taking and transmitting vertical and horizontal loads (seismic) is ensured only by the reinforced concrete structure. However, experience from past earthquakes around the world has shown that this calculation approach is simplifying and approximate, because we have found during the analysis of earthquake damage that the neglect of masonry walls in calculations can decisively influence and even upset the response of structures to seismic forces. The tests carried out in our research and the numerical modelling carried out on several cases have shown that the effect of shear stress on gantry masonry structures can be taken into account by replacing in the numerical modelling the masonry with equivalent diagonals whose thickness will be calculated according to the physical and mechanical characteristics of the gantry and the masonry.

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1. INTRODUCTION

The intensity of the seismic forces acting on a building during an earthquake is conditioned not only by the characteristics of the seismic movement, but also by the rigidity of the stressed structure.

The various cases of damage observed in the past have revealed the vulnerability of self-stable portal structures (posts- beams), these structures represent the largest percentages of the housing stock, their filling is ensured with hollow brick under form of panels. Portal structures with masonry are considered to be very vulnerable to stresses.

Seismic. Most of the works made with this type of construction have undergone significant damage in affected areas.However even if the taking into account of the presence of the filling turns out to be of economic interest, the safety practice wanted this contribution to be ignored in the calculations because of the absence of a practical method and a regulatory tool.

Studies by researchers and experts have revealed that these fillings are not always safe, they can however promote the rupture of certain frameworks, and even upset the behavior of structures .

During our research we found the absence of analytical studies and applications on real buildings using Moroccan standards. The only work published by Mr. R. ZAIN (author of this article) concerns an experimental study on the determination of the width of the equivalent diagonal representative of the behavior of its walls.

That is why the objective of our work is to make analytical and comparative studies on a building of 15 floors and two basements, and this to better understand the risks related to the ignorance of the behavior of these walls in the real and global behavior of structures.

2. RESEARCH METHOD

The objective of the thesis is to complete and contribute to existing research and knowledge on the behavior of masonry walls with respect to the shearing force.

2.1 Description of the studied structures

It is about the construction of a hotel of 3 stars in 15 floors (IBIS) in the quarters of the hospitals in MAARIF Casablanca.
This hotel conceived on twelve floors and having a contemporary architecture, it proposes 157 rooms, a meeting room of 20 persons and spaces of co-working, it is also endowed with a parking lot, a restaurant, an amphitheatre, premises of reserves, halls...

Table 1.Dimensions of the building studied

Floors	Length(m)	Width(m)	Height(m)
underground 1	28,92	19,50	2,68
underground 2	28,92	19,50	2,68
ground floor	28,92	19,50	5,45
1	42,00	9,50	3
2	42,00	9,50	3
3	42,00	9,50	3
4	13,80	19,00	3
5	13,80	19,00	3
6	13,80	19,00	3
7	13,80	19,00	3
8	13,80	19,00	3
9	13,80	19,00	3
10	13,80	19,00	3
11	13,80	19,00	3
12	13,80	19,00	3
13	13,80	19,00	3
14	13,80	19,00	3
15	13,80	19,00	3
	total area (m2)	119183,4	
	total height (m)	55,81	

2.1.1 Macro-modeling of masonry infill walls

In our study, the masonry is modeled by a single concentric equivalent diagonal link. In this research, the method of Durani confirmed by the experiment will be used for the modeling of masonry walls, the diagonal rod will take the same mechanical characteristics of the concrete material.

2.1.2 Non-linear modeling of structural elements

The nonlinear behavior of the building must be modeled in order to perform a nonlinear static analysis. This requires the development of the force-deflection curve for the critical sections of the masonry beams, columns and infill walls.

2.1.3 Modeling Software

Robot Structural Analysis Professional is a structural analysis program using the finite element method. It allows non-linear static and dynamic analysis of plane or three-dimensional structures subjected to vertical and horizontal static actions as well as to seismic actions. Seismic actions can be taken into account by equivalent horizontal forces or by ground level accelerograms.

2.2 Models considered for the analysis

The models developed are:

Structure without taking into account the effect of masonry infill on the overall behavior of the structure;
Structure with the effect of masonry filling on the global behavior of the structure.

2.3 Objective of the comparison

The objective of this study is to prove by a spectral modal analysis, the deficiency of the current seismic regulations to represent well the influence of the masonry infill walls on the seismic behavior of a reinforced concrete portal frame structure subjected to seismic action, this by comparing the seismic responses resulting from the modeling of the presence of the infill by a single equivalent diagonal rod according to the formulation of Durani argued experimentally.

2.4 Comparative technical study

Static and dynamic calculation assumptions of the structure.

2.5 Description of the project

The studied structure is a building R+15, with a total surface of 1500 m².

2.5.1 Adopted regulations

BAEL 91 modified 99: for the reinforced concrete calculations ;
RPS2000 modified 2011: for the seismic calculation ;
PS92 : complementary to RPS2000 ;
NV65 : for the wind calculation ;
Fascicule N62: for the calculation of foundations.

2.5.2 The characteristics of materials

2.5.2.1 Concrete:

A concrete dosed at 350 Kg / m3 with the following characteristics will be used:
Characteristic compressive strength of concrete: fc28=25 MPa
Characteristic tensile strength of concrete: ft28=0,06 fc28 +0,6=2,1 MPa.
Volumetric weight: ρ=2500 Kg / m3.
Modulus of elasticity E=11000*(fc28) (1/3) =34 180 MPa
Design stress of the concrete at ULS: σbc=15 Mpa
Not very detrimental cracking (ELS)
Cracking detrimental to the foundations.

2.5.2.2 Steel:

For the reinforcement, steel with the following characteristics is used:
Elastic limit of the steel: fe=500 MPa
Design stress of the steel at ULS: σsu=434.78MPa
Longitudinal modulus of elasticity: E=210 000 MPa.
Steel coating: it is taken equal to:
e=5cm for the inverts (face in contact with the ground)
e=4cm for the faces in contact with water
e= for the other cases
Meshing method used: Delaunay with a regular mesh.

2.5.3 Seismic characteristics of the project according to RPS2000 modified 2011

Acceleration factor (A)
According to the seismic zoning map, our project is located in Casablanca, so we are in zone 2 where: A= 0.08 g (Probability 10% in 50 years)
Site coefficient (S)

According to the geotechnical report the project site is classified as S1 type, hence S=1
Priority Coefficient (I)
Our project is a standard building for residential, office and commercial use and is therefore classified as Class 2, hence I= 1
Damping coefficient (ξ)
The structure being reinforced concrete therefore, ξ = 5%.
Behavior factor (k)
Our structure will be taken as not very ductile (ND1) and the main bracing will be provided by walls, hence k =1.4
Seismic priority classes
It is a building for hotel use, so it belongs to class III, a priority coefficient equal to 1.

2.5.4 The characteristics of materials

2.5.4.1 Concrete Permanent loads

In addition to the structure's own weight, the permanent loads that will be applied are:
Terrace :
- Form of slope 250kg/m²;
- Waterproofing : 12kg/m²;
- Thermal insulation 15kg/m² ;
- Waterproofing protection 100kg/m².

Current floor :
- Floor covering: 140kg/m²;
- Coating/false ceiling including hangers: 30kg/m²;
- Double partitions:240kg/m2;
- Various networks : 20kg/m2.

2.5.4.2 Operating loads

The operating loads in the buildings are in accordance with the values fixed by the standard NFP 06-001 of June 1986.
The operating loads, not weighted, retained are :
- Accessible terrace: 150kg/m²;
- Stairs: 250kg/m²;
- Rooms and sanitary facilities: 150kg/m²;
- Circulations DRC : 400kg/m2;
- Storage room : 500kg/m2;
- Circulation floor : 250kg/m2;
- Restaurant/main hall :400kg/m2;
- Amphitheater :400 kg/m2;
- Inaccessible terrace/covering;
- Technical roofing 1000kg/m2.

2.6 Modeling of the structure

The structure was modeled on design and modeling software as shown in the figure below:

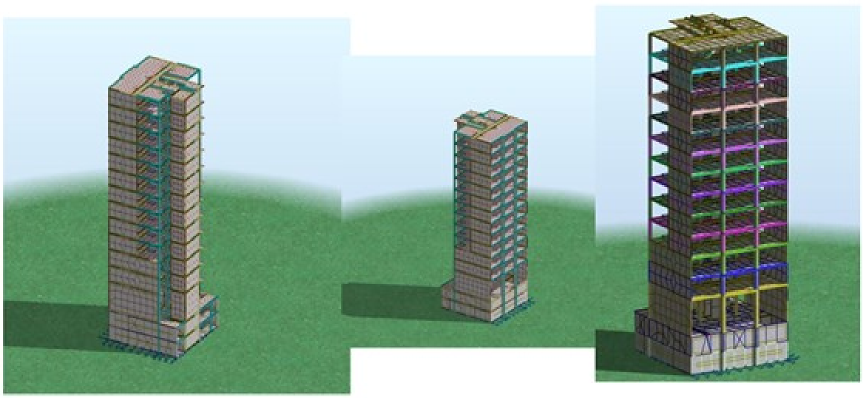

Figure 1. Structure without masonry infill.

In the figure above, the structure is modeled under Autodesk Robot Structural Analysis without taking into account the effect of the infill walls in the overall behavior of the structure, it is with this method that all structures in Morocco are modeled.

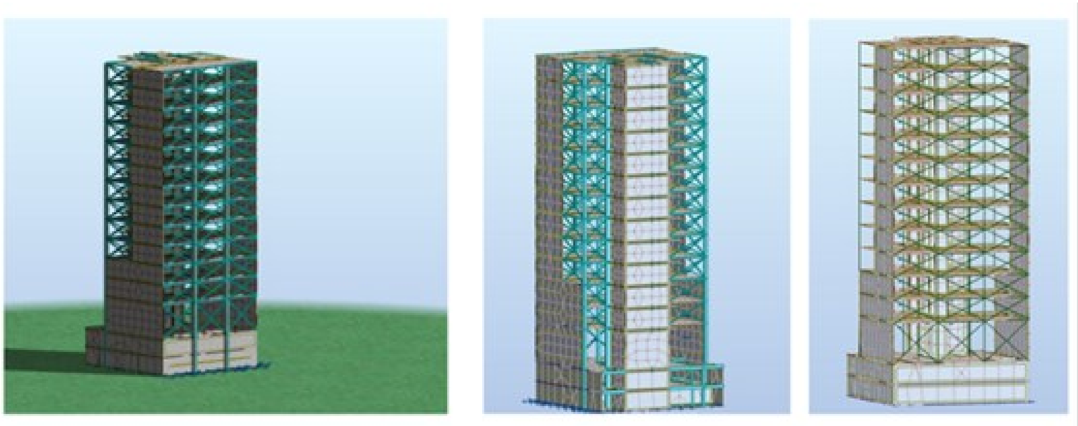

Figure 2. Structure with masonry filling.

In the figure above, the structure is modeled with Autodesk Robot Structural Analysis software but taking into account the effect of the infill walls in the overall behavior of the structure, the infill walls have been modeled as equivalent diagonal bars following the method of Durani.

3. RESULTS AND DISCUSSIONS

3.1 Modal Analysis Results and discussions

Considering sixty modes of vibration, the results of the spectral modal analyses carried out, in the longitudinal X direction and in the longitudinal Y direction, on the two models presented previously, treated both with and without rods, are presented and discussed. The evaluation of the effect of infill on the dynamic responses of reinforced concrete portal frame buildings is discussed and compared in this section.
After trial and error, 60 modes were selected, and the results of the modal analysis are summarized in the following table:

Table 2. Modal analysis of the structure without filling

Mode	Frequency[Hz]	Period [sec]	Cumulative Weights UX [%]	Cumulative Weights UY [%]	Cumulative Weights UZ [%]
1	0,55	1,81	1,66	58,48	0
2	1,04	0.96	62,88	61,86	0,07
3	1,38	0.73	64,37	66,44	0,07
4	2,68	0.37	66,12	76,45	0,2
5	3,96	0,25	66,21	76,45	44,15
6	4,43	0,23	66,26	76,78	47,51
7	4,7	0,21	66,37	76,78	50,39
8	4,97	0,20	69,7	77,12	50,41
9	5,06	0,20	71,27	77,4	53,24
…	…	…	…	…	…
59	6,65	0,15	80,92	83,47	60,46
60	6,75	0,15	80,98	83,48	60,58

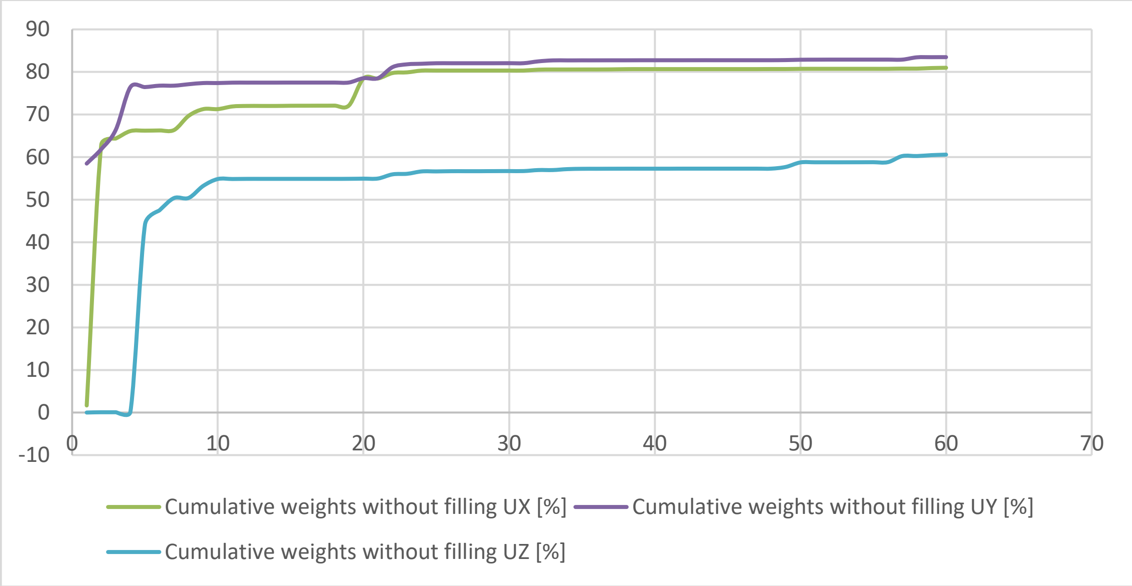

Figure 3: The evolution of the cumulative masses in the three directions for the structure without masonry

We note that the variation of the mass participation is very slow for the last modes and that the first 60 modes are not sufficient to have a mass participation greater than or equal to 90%, so we used the residual mode to respect the effect of the percentage set by the seismic standard, the value of the frequency of the last mode of 6.75 Hz, indicates that the stiffness of the load-bearing elements (poles), is normal compared to the weight of the building, so we have a good mass-rigidity ratio.
According to the animations made on software, modes 1 and 2 are modes of translations, and mode 3 of torsion.

Table 3. Modal analysis of the structure with filling

Mode	Frequency[Hz]	Period [sec]	Cumulative Weights UX [%]	Cumulative Weights UY [%]	Cumulative Weights UZ [%]
1	0,55	1,81	0.83	66.98	0
2	1,04	1,24	65.78	68.08	0,07
3	1,38	1,22	66.04	68.28	0,08
4	2,68	1,15	67.04	78.77	0,41
5	3,96	0,75	67.23	78.80	44,67
6	4,43	0,53	67.34	79,06	48,49
7	4,7	0,39	67.39	79.07	51.28
8	4,97	0,25	67.68	79.08	52.20
9	5,06	0,24	67.87	79.10	52,44
…	…	…	…	…	…
59	6,65	0,16	81.13	83,76	61,21
60	6,75	0,16	81.13	83,76	61,21

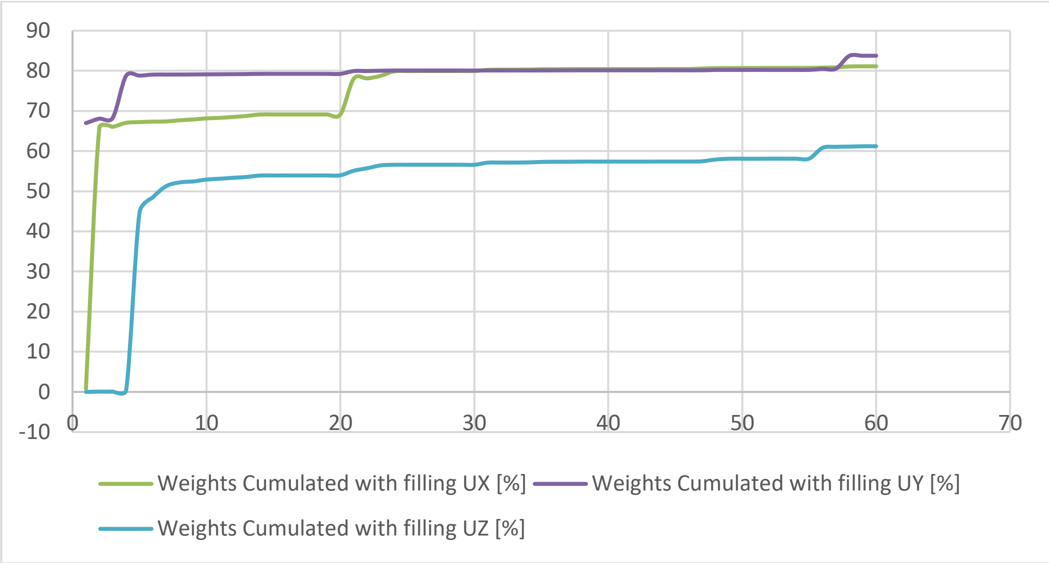

Figure 4: The evolution of the cumulative masses in the three directions for the structure with masonry

We note that the mass participation is greater than 90% and the value of the frequency of the last mode is 6.77 Hz, these two results meet the values required by the RPS 2000 modified 2011, they also indicate that the stiffness of the load-bearing elements (columns), is normal compared to the weight of the building, so we have a good mass-stiffness ratio.

According to the animations made on software, modes 1 and 2 are translational modes, and mode 3 is torsion.

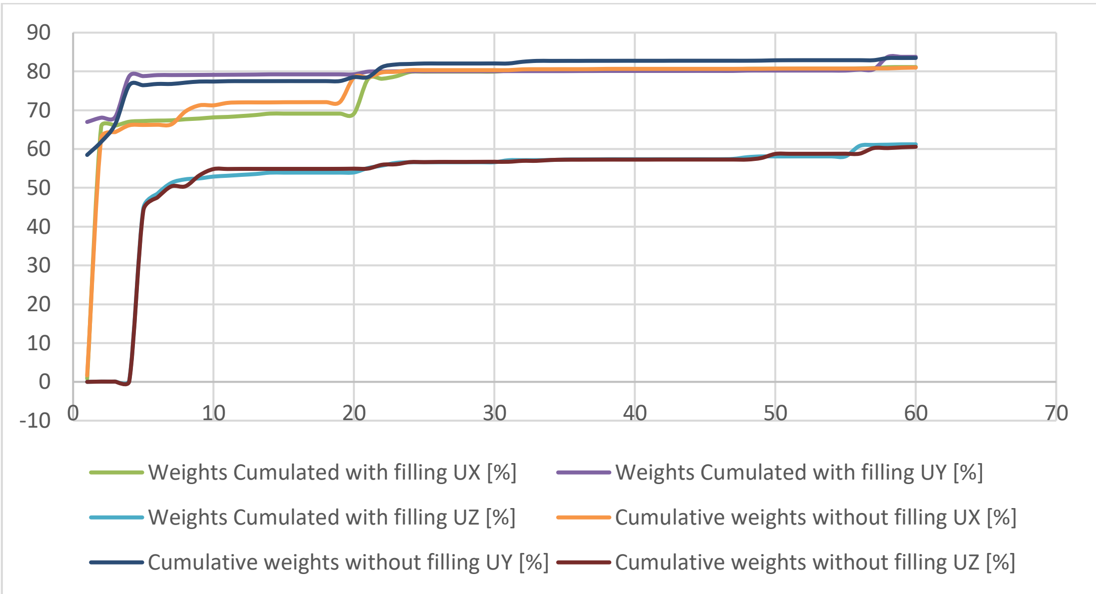

Figure 5: The comparative evolution of the cumulative masses in the three directions for the two structures

Comparing the two structures, it is clear that the consideration of masonry walls in the modeling of structures increases the mass participating in the overall response of the structure to seismic forces.

3.2 Response in terms of fundamental natural period

We observe that the model without filling (without connecting rod) gives a longer period compared to the models with filling. The results indicate that the introduction of the fill drastically reduces the period of vibration in the construction models by about 20% on average compared to the model without fill. This is due to the addition of the lateral stiffness provided by the connecting rod to that provided by the columns and walls, which expresses that the natural period depends mainly on the stiffness and mass of the structure.

By analyzing the current Moroccan seismic regulations (RPS2000/version2011), we deduce that the presence of the infill walls has no effect on the value of the main period of the structures. This is explained by the fact that the value of the behavior factor has no influence on the estimation of the natural period which depends mainly on the stiffness and mass of the structure when the percentage of the damping coefficient is low, Similarly, the empirical formula used for the calculation of the fundamental period of vibration is a function of the total height of the building and the length of the wall that constitutes the main bracing system in the direction of the seismic action (Article 6. 3 of RPS 2000 amended 2011).

3.3 Basic shear force of the structure

According to Section 6.4.1.b of the 2011 amended RPS2000, the value of the seismic lateral force V used in the calculation shall not be less than 0.90 times the value obtained by the equivalent static approach.

3.3.1 Structure without masonry infill:

Basic shear forces (spectral modal analysis) for the structure without infill: from Autodesk Robot structural analysis:

- Tx=2265.40KN
- Ty=1956.10 KN

3.3.2 Structure with masonry infill:

Basic shear forces (spectral modal analysis) for the structure with infill: from Autodesk Robot structural analysis:

- Tx=2828.70KN
- Ty=2436.60 KN

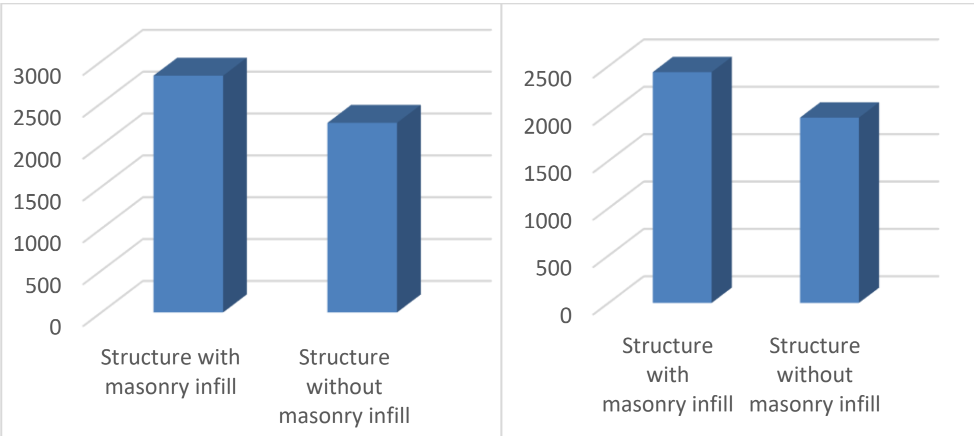

Figure 6: The comparative evolution of the Basic shear forces for the two structures

the shear force due to the presence of the infill is quite important, which will further increase the dimensioning of the load-bearing elements and consequently the resistance of the structure to shear, hence the obligation to take into account the effect of infill in the calculations of structures to avoid undersizing the structures and load-bearing elements of buildings.

3.4 Floor Shear Response:

As shown in the table, the storey shear force response for the model without rigid infill shows a smaller transmission of shear forces, approximately 20% on average, at the base and superstructure than those transmitted to the building models with rigid masonry infill. From a seismic design point of view, ignoring the masonry infill wall action significantly underestimates the base shear force, which is considered one of the main parameters during the design stages, and can therefore lead to an excessively safe but very costly design.

3.5 Interstage Lateral Displacements :
The inter-story lateral displacements Del evaluated from the design actions are schematized in the following table:

3.5.1 Structure without masonry infill:

Table 4. Inter-storey lateral displacements for the structure without masonry filling

Floor	Height(m)	Earthquake following the X direction		Earthquake following the Y direction		Displacement inter-floor limit (cm)
		Ux (cm)	Uy(cm)	Ux(cm)	Uy(cm)	
1	2,7	0,12	0,02	0,03	0,12	1,93
2	2,7	0,13	0,05	0,03	0,18	1,93
3	5,45	0,3	0,22	0,12	0,76	3,89
4	3	0,19	0,13	0,08	0,5	2,14
5	3	0,2	0,12	0,09	0,52	2,14
6	3	0,25	0,11	0,13	0,59	2,14
7	3	0,28	0,11	0,15	0,64	2,14
8	3	0,3	0,11	0,17	0,68	2,14
9	3	0,31	0,11	0,19	0,72	2,14
10	3	0,32	0,11	0,2	0,74	2,14
11	3	0,33	0,11	0,21	0,76	2,14
12	3	0,34	0,12	0,21	0,77	2,14
13	3	0,34	0,12	0,21	0,77	2,14
14	3	0,33	0,12	0,21	0,76	2,14
15	3	0,33	0,13	0,21	0,75	2,14

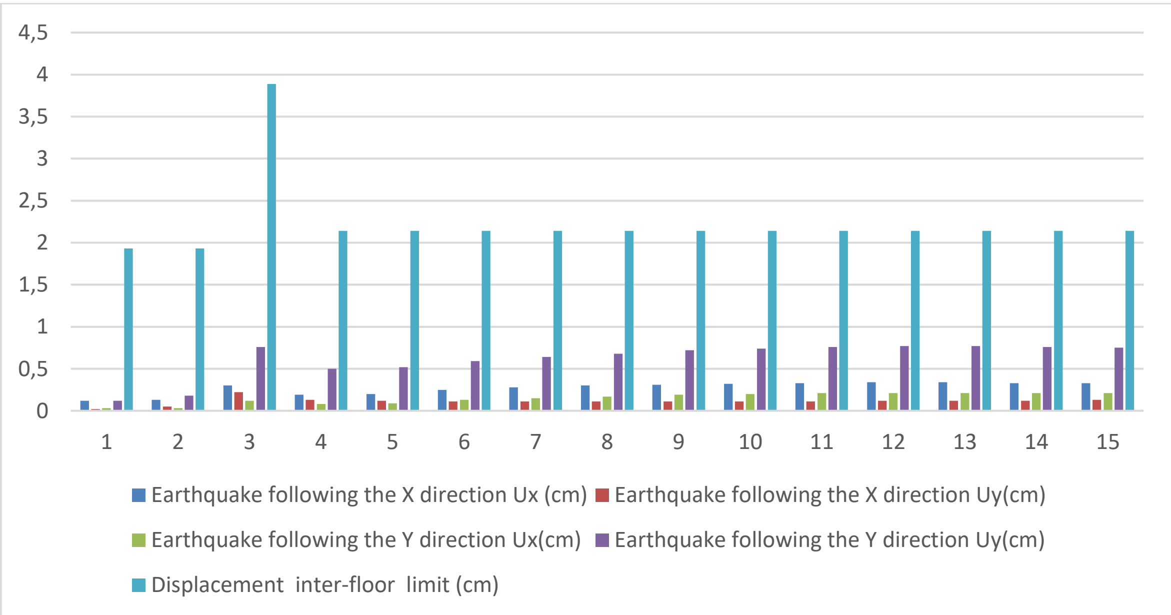

Figure 7: inter-storey movements of the structure without infill walls

after analysis of the figure above, we notice that all the displacements are lower than the limit displacements required by the Moroccan paraseismic norm, the maximum displacement is in the head of the building. we conclude that the structure is rigid, the limit displacements are largely superior to the displacements due to the seismic forces.
When the seism is in the X direction the displacements in this direction are much higher than in the Y direction and vice versa for the seism in the Y direction.
the maximum displacement is 0.76 cm in the Y direction, this is due to the low stiffness of the structure in this direction due mainly to the design of the building.

3.5.2 Structure with masonry filling:

Table 5. Inter-storey lateral displacements for the structure with masonry filling

Floor	**Height(m)**	**Earthquake following the X direction**		**Earthquake following the Y direction**		**Displacement inter-floor limit (cm)**
		Ux (cm)	Uy(cm)	Ux(cm)	Uy(cm)	
1	2,7	0,1	0,02	0,02	0,1	1,93
2	2,7	0,12	0,03	0,02	0,16	1,93
3	5,45	0,3	0,11	0,06	0,6	3,89
4	3	0,19	0,06	0,04	0,38	2,14
5	3	0,21	0,06	0,05	0,39	2,14
6	3	0,25	0,05	0,06	0,4	2,14
7	3	0,27	0,05	0,06	0,41	2,14
8	3	0,28	0,04	0,06	0,42	2,14
9	3	0,29	0,04	0,07	0,42	2,14
10	3	0,3	0,04	0,07	0,42	2,14
11	3	0,3	0,04	0,06	0,41	2,14
12	3	0,3	0,04	0,06	0,4	2,14
13	3	0,29	0,04	0,06	0,39	2,14
14	3	0,29	0,04	0,06	0,37	2,14
15	3	0,29	0,04	0,06	0,35	2,14

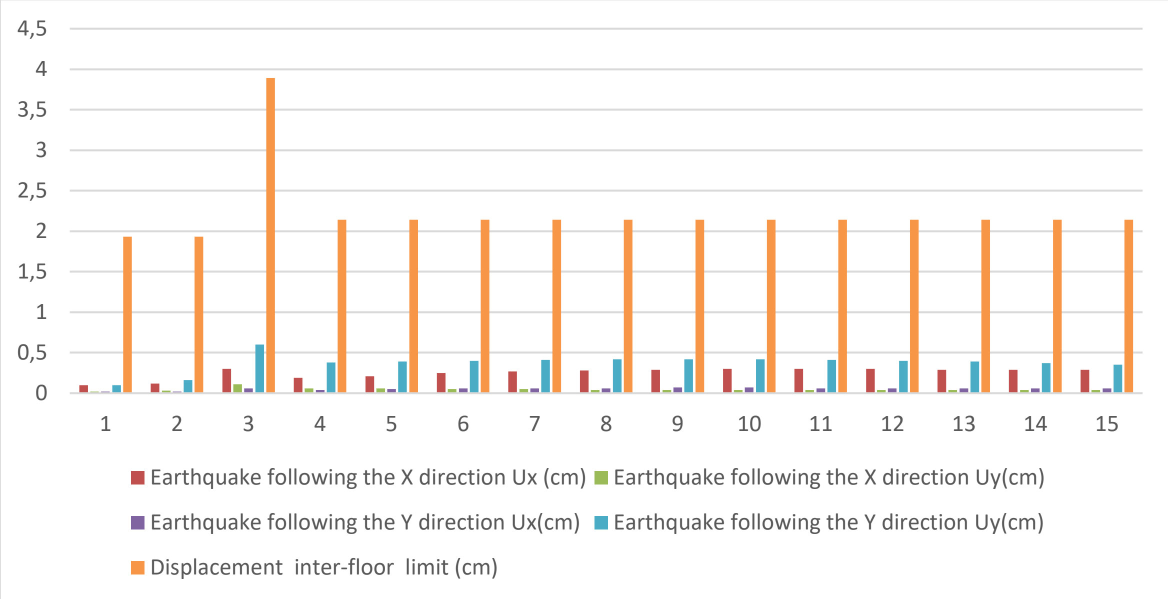

Figure 8: inter-storey movements of the structure with infill walls

We can see that not taking into account the effect of the infill resulted in higher global displacements compared to the structure with infill.
It can also be observed from the table, that the displacements obtained at each floor level are significantly higher for the model without infill compared to the model with rigid masonry infill, especially at the upper floors of the building.
This is due to the increase in the stiffness of the building with the consideration of the action of the masonry infill wall.
It is also noted that the inter-storey displacements obtained at each floor level for the model without infill are significant but do not exceed the limit allowed suggested by the seismic regulations of Morocco. We also notice that the inter-storey displacements obtained at each floor level for the model without rigid filling, are considerably high, compared to the model with filling. This is probably due to the increase in the stiffness of the building with the consideration of the action of the masonry infill wall. By considering the action of the masonry infill wall in the building modeling, it decreases the values of the induced inter-story displacements. It can be noticed that the inter-story displacement response of the floors for the model without infill shows identical values at the base and superstructure as those obtained for the building models with rigid masonry infill, which proves that this unrealistic behavior does not reflect the physical reality of the effect of the presence of the rigid infill walls on the inter-story displacement response of the portal structures.

3.6 Stability of the structure at overturning

3.6.1 Structure without masonry infill (X direction)

Table 6. Tipping stability of the masonry structure without infill in the X direction

Floor	W(.KN)	depmax(inter-floor dep) (cm)	V(seismic force) (KN)	h(floor height) (cm)	θ
1	12655,47	0,19	2665,4	270	0,007
2	3363,79	0,13	2323,4	270	0,001
3	3121,12	0,31	2159,7	545	0,002
4	2306,08	0,19	2032	300	0,001

5	2312,52	0,21	1937,8	300	0,002
6	2146,9	0,25	1842,3	300	0,002
7	2146,9	0,27	1740,9	300	0,002
8	2146,9	0,28	1633,1	300	0,002
9	2146,9	0,29	1522,4	300	0,003
10	2146,9	0,3	1400,5	300	0,003
11	2146,9	0,3	1263,9	300	0,003
12	2146,9	0,3	1102	300	0,004
13	2146,9	0,29	903	300	0,005
14	2146,9	0,29	652,2	300	0,006
15	2146,9	0,29	350,7	300	0,012

According to Article 8.2.3 of Moroccan seismic regulations 2000 amended 2011, the stability of the structure to overturn is ensured according to the stability index which is less than 0.1.

3.6.2 Structure without masonry infill (Y direction)

Table 7. Tipping stability of the masonry structure without infill in the Y direction

Floor	W(KN)	depmax(inter-floor dep) (cm)	V(seismic force) (KN)	h(floor height) (cm)	θ
1	12655,47	0,07	1965,1	270	0,005
2	3363,79	0,14	1573,3	270	0,002
3	3121,12	0,76	1431,5	545	0,006
4	2306,08	0,50	1349,5	300	0,006
5	2312,52	0,52	1278,7	300	0,006
6	2146,90	0,59	1203,2	300	0,007
7	2146,90	0,64	1130,4	300	0,008
8	2146,90	0,68	1062,3	300	0,009
9	2146,90	0,72	996,5	300	0,010
10	2146,90	0,74	924,4	300	0,011
11	2146,90	0,76	842,9	300	0,013
12	2146,90	0,77	746,6	300	0,015
13	2146,90	0,77	626,2	300	0,018
14	2146,90	0,76	466	300	0,023
15	2146,90	0,75	258,6	300	0,042

According to Article 8.2.3 of Moroccan seismic regulations 2000 amended 2011, the stability of the structure to overturn is ensured according to the stability index which is less than 0.1.
the risk of overturning the structure if the seism strikes in the Y direction is greater

3.6.3 Structure with masonry infill (direction X)

Table 8: Overturning stability of the masonry structure with filling in the X direction

Floor	W(KN)	depmax(inter-floor dep) (cm)	V(seismic force) (KN)	h(floor height) (cm)	θ
1	12655,47	0,11	2828,7	270	0,004
2	3363,79	0,13	2492,7	270	0,001
3	3121,12	0,31	2328,2	545	0,002
4	2306,08	0,19	2195,7	300	0,001
5	2312,52	0,21	2096,5	300	0,002
6	2146,90	0,25	1995,6	300	0,002
7	2146,90	0,27	1887,2	300	0,002
8	2146,90	0,28	1769,4	300	0,002
9	2146,90	0,29	1645,5	300	0,003
10	2146,90	0,30	1506,4	300	0,003
11	2146,90	0,30	1349,9	300	0,003
12	2146,90	0,30	1167	300	0,004
13	2146,90	0,29	947,4	300	0,004
14	2146,90	0,29	677,9	300	0,006
15	2146,90	0,29	361,2	300	0,011

3.6.4 Structure with masonry infill (direction Y)

According to Article 8.2.3 of Moroccan seismic regulations 2000 amended 2011, the stability of the structure to overturn is ensured according to the stability index which is less than 0.1.

Table 9. Overturning stability of the masonry structure with infill in the Y direction.

Floor	W(KN)	depmax(inter-floor dep) (cm)	V(seismic force) (KN)	h(floor height) (cm)	θ
1	12655,47	0,10	2436,6	270	0,004
2	3363,79	0,16	2090,9	270	0,002
3	3121,12	0,60	1952,8	545	0,004
4	2306,08	0,38	1859,8	300	0,003
5	2312,52	0,39	1780,1	300	0,003
6	2146,90	0,40	1687,5	300	0,003
7	2146,90	0,41	1584,2	300	0,004
8	2146,90	0,42	1475,8	300	0,004
9	2146,90	0,42	1369,2	300	0,004
10	2146,90	0,42	1257,3	300	0,005
11	2146,90	0,41	1134,9	300	0,005
12	2146,90	0,40	989,6	300	0,006
13	2146,90	0,39	809,2	300	0,007
14	2146,90	0,37	581,1	300	0,009
15	2146,90	0,35	309,2	300	0,016

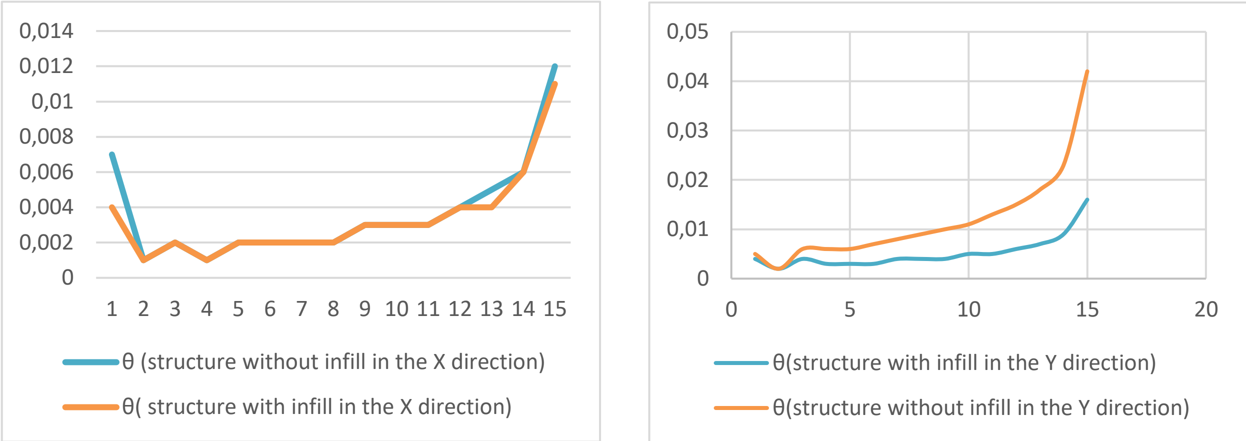

Figure 9: comparison of the stability index between the different structures and directions

From the figure above, it is clear that the stability index of structures with the infill effect taken into account is lower than the same index for structures where the infill effect is ignored and this in both directions, this is mainly due to the contribution of stiffness of these walls in the overall response of the structure to horizontal forces

According to Article 8.2.3 of Moroccan seismic regulations 2000 amended 2011, the stability of the structure to overturn is ensured according to the stability index which is less than 0.1.

the risk of overturning the structure if the seism strikes in the Y direction is greater

It can be observed from the tables that the p-Δ effects obtained at each floor level for the model without infill are significant but do not exceed the allowable limit suggested by the RPS of 0.1. It is also noticed that the p-Δ effects obtained at each floor level for the model without infill, are considerably high, compared to the model with masonry infill, This is due to the increase in the stiffness of the building with the consideration of the masonry infill wall action.

By considering the action of the masonry infill wall in the building modeling, it decreases the values of the induced p-Δ effects.

It can be seen also, that the response in terms of P-Δ effect of floors for the model without infill displays higher values at the base and superstructure than those obtained for the building models with rigid masonry infill.

It is also concluded that the model that ignores the masonry infill wall action significantly underestimates the overturning moments compared to the model that takes the infill action into consideration. The induced overturning moments for the portico building model with fully filled masonry walls and those without fill show significant changes in the values obtained at the upper floors. However, the change in moments is slightly pronounced at the lower floors.

4. CONCLUSION

The modes of ruin of buildings under the effect of past earthquakes have shown that a perfect control of the structure is possible only by a correct modeling of the masonry walls, in our project we studied the influence of the horizontal effort on the behavior of the structures

A comparative study is carried out on the impact of masonry infill walls on the seismic behavior of a 15-storey reinforced concrete portal frame building, by modeling, on the one hand, the presence of masonry infill walls by a single equivalent diagonal rod and by applying the recommendations of the Moroccan seismic regulations (RPS2000/version 2011), on the other hand To this end, a dynamic modal spectral analysis of different models of three-dimensional buildings of 15 floors such as bare frame and frame with infill panels on the entire height.

The analysis results obtained in this work indicate that the seismic response of reinforced concrete building models analyzed with the modeling of the action of masonry infill walls with an equivalent diagonal connecting rod is significantly more realistic and representative of the portal-fill interaction than that of buildings modeled according to the seismic regulation RPS2000 modified 2011.

with regard to the Moroccan seismic regulations, it can be said:

Surestimate considerably the value of the fundamental period for all constructions with integral rigid filling or having transparency. It provides an identical value of the period for all models, which does not reflect the mechanical action of the presence or absence of the filling.;
Relatively underestimates the floor shear forces for infilled construction, which affects the design and cost of the structure;
Significantly overestimates the values of all storey displacements for constructions with infill. It provides identical storey displacements for both models indicating its insensitivity to the presence of infill;
Significantly overestimates the inter floor displacements;
Significantly overestimates the P-Δ effects of floors for structures with fill, this regulation provides larger values of the P-Δ effects of floors for structures with fill than those provided for structures without; infill, something that contradictorily reflects the expected action of the integral presence of infill walls;
Underestimates the overturning moment for structures with infill, this regulation gives values of overturning moments of floors for structures with rigid infill significantly less important than those provided for structures without infill, something that goes against the expected action of the integral presence of infill walls. The current Moroccan seismic regulation RPS2000/2011 gives results that do not correctly reflect the influence of the infill on the overall behavior of the structure when subjected to lateral forces. These findings confirm the usefulness and necessity of incorporating the modeling of the action of the presence of the infill walls by an equivalent diagonal rod in the current Moroccan seismic regulations.
Following the last seismic events in the world (Turkie) and having exceeded 12 years of application, the Moroccan seismic regulation must be revised urgently to allow a good dimensioning of structures, this regulation must be the subject of a thorough study and taking into account all the data related to non-bearing elements (masonry wall, equipment, flexible floor ...) because it is the latter that can upset any ordinary calculation made

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