Performance of Lightweight Shear Walls on Reinforced Concrete Buildings Under Seismic Loads

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Abstract: A shear wall was defined as a vertical structural element that transmits gravity loads to the foundation while resisting lateral loads caused by wind and seismic activity. Present study, the performance of reinforced lightweight concrete shear walls under the effect of seismic loads is considered with different loading types as static as equivalent static analysis and dynamic as time history analysis applied to reinforced concrete frame buildings with and without the presence of reinforced lightweight concrete shear walls. The models are simulated using the finite element method by SAP2000 software. Displacements, drifts, building performance, and base shear are evaluated for all cases of loading. The analysis results indicated that the presence of reinforced concrete shear walls led to reduced displacements, drifts, and increases in frequency under static seismic load and also reduced deformation under time history loading and an additional increase in base shear resistance with more stability and an increase in overall stiffness of the building. Also, include the results. The base shear resistance of Normal weight building with lightweight shear walls (NWB-LWS) is lower than that of Normal weight building with normal weight shear walls (NWB-NWS) due to the reduced building mass. The applied static and dynamic loadings did not cause any structural members to fail That is, by using different methods of seismic analysis. The difference in the weights of the different shear walls was about (19.7%).

Keywords: Reinforced lightweight concrete shear wall, Seismic loading, Dynamic analysis, SAP2000, Time history.

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1. Introduction

Reinforced concrete shear walls are the primary structural components, particularly in high-rise structures. Shear walls provide a structure with extra strength and stiffness, which lowers lateral deformations in the direction of their orientation. There are a lot of horizontal earthquake forces that shear walls can carry, which lessens the effects of ground movement on all floors. Despite the fact that several research programs have investigated the performance of lightweight concrete structural elements, there is a limited understanding of the behavior of lightweight shear walls under seismic conditions, so understanding the performance and strength of reinforced lightweight concrete shear walls under seismic loadings is critical. In the case of a seismic event, the fundamental purpose of a shear wall is to resist ground motion and transmit it to all floors of the building. The bulk of modern construction, particularly high-rise buildings, uses RCSW (reinforced concrete shear wall) to improve the overall stability and stiffness of the structural parts. Lightweight concrete has a low density and may be used to construct structures in low-seismic zones because of its adaptability. Because structural seismic reactions are based on the mass of the building or the dead weight of the structure, it is important to use materials that keep the dead weight of the structure as low as possible [1].The low density, low thermal conductivity, low shrinkage, and high heat resistance of low-density lightweight concrete make it a good choice for building. It also reduces the dead load, saves money on transportation, and speeds up the building process. Aim of the study: To evaluate the performance of reinforced concrete buildings with and without lightweight reinforced shear walls under the influence of seismic loads. The mode of failure of reinforced shear walls is very complex when they are subjected to vertical and in-plane shear loads that rely on the aspect ratio and reinforcement ratio in addition to the concrete compressive strength of the shear wall [2]. Werasak Raongjant and Meng Jing ,2008 [3]. In this study a three dimensional model of lightweight reinforced concrete shear walls. Four models of lightweight reinforced concrete shear wall with varying web reinforcements were evaluated and simulated (orthogonal grids or diagonal bars). The nonlinear behavior of lightweight reinforced shear walls subjected to seismic stresses was simulated using finite elements method. Based on the analysis results, the inclined web reinforcement successfully transferred shear forces to the foundation and decreased the shear forces carried by compression beams. J .Carrillo et al. (2015)[4]. In order to understand the effects of lightweight and low-strength concrete on shear strength and displacement related to various limit states of thin, lightly-reinforced shear walls in various limit states, they carried out an experimental study that included quasi-static cyclic tests and shake table tests on twenty walls. When comparing normal weight and lightweight concrete, the effects on mechanisms, displacement capacity, and initial stiffness of undamaged walls, stiffness deterioration, and energy dissipation were all considered to be significant. Experimentation study results Compared to conventional concrete walls, lightweight concrete walls had higher shear strength and energy dissipation in various boundary states, which indicated that they were more resistant to shear. Jianbao Li et al, 2017 [5], the effect of seismic loadings on laminated RCSW (Reinforced concrete shear wall) was studied. The RCSW was assessed based on stiffness degradation, energy dissipation, failure mechanism, and deformability study findings. The models were simulated in ABAQUS using the finite element method, employing the RCSW model and experimental testing data. The laminated RCSW offers good seismic performance, according to analysis and test results. S. Marzban et al, 2014[6], the impacts of soil as well as soil-structure interaction on the performance of RCSW subjected to seismic loadings were investigated. The different stories of reinforced concrete structures made out of RCSW, such as 3, 6, 10, and 15 stories .The findings of the analysis revealed that the boundary of the base of the wall had an effect on the behavior and strength of the RCSW when seismic loadings were applied. S.R. Thorat and P.J. Salunke, 2014[7] , RCSW and braced concrete frame behavior under earthquake loadings were compared. The comparisons focused on three metrics under the influence of lateral loadings: strength, stiffness, and ductility. The study's shear walls and braced frame section. According to the findings of the research, the position of the shear wall and braced frame affects the building's seismic response, with the ideal site being in the middle of the structure. The displacements and drifts were minimized by the braced frame compared to the shear wall.F. Y. Al-Ghalibi and Laith Al-Hadithy, 2018[8], The performance of RCSW when subjected to seismic loads was examined. In the reviewed work, various topics were emphasized, such as boosting the RCSW stiffness, ductility, and energy dissipation by replanting steel sections inside the wall, such as plate of I sections. Al-Baghdadi, H., 2014, [9]. The scale-down building was made of RCSW and was exposed to seismic dynamic skew dynamic loads. According to analysis and test findings, the elastic and inelastic responses of RCSW were strongly impacted by applied dynamic loadings. Waugh, J., et-al. 2008, [10] RCSW was subjected to nonlinear analysis under the influence of seismic loadings. RCSW was examined in a variety of layouts, including rectangular and T shapes. Closed and the real border as actual was the best technique to represent concrete walls as finite elements, according to numerical and test findings. Muthukumar, G., and Kumar, M., 2014[11] , The effects of seismic loadings on RCSWs with apertures were investigated. The performance of RCSW was investigated using nonlinear finite element modelling and dynamic seismic loadings. Small apertures within a wall showed good displacement response, according to the results.El-Azizy, O., et. al. 2015[12], Under the effects of lateral loadings, the effects of wall end configurations and forms, such as rectangular and flanged, as well as boundary element type, were studied. The vertical and horizontal rebar ratios, as well as the features, were modified. The authors concluded that the test findings matched the CSA-A23.3-14 Canadian code. Flanged and boundary wall sections also have higher ductile capacities than rectangular sections. Baetu, S., et.al. 2011 [13]. ANSYS software was used to simulate RCSW using a modified nonlinear numerical analysis and a finite element technique. The RCSW with the slit functioned as a passive control system, resulting in a damping mechanism. When the shear connection yields, the damping system improves and the ductility of the entire structural system improves. Because the yield point of the shear connections has been reached, slit walls are more appropriate in strong seismic zones. When compared to walls without slits, the structure collapsed due to plastic hinge failure, which was averted under extreme seismic stress due to the high ductility offered to the structure when shear connections yielded. Astriana, L., et.al. 2017[14], Using seismic fragility curves, we were able to predict the behavior of a concrete frame (moment resistant) with a shear wall. It is considered that the damage degree of a structure is determined by probabilistic functions based on seismic intensity (spectral acceleration) (fragility curves). The damage stages of the two structural systems were estimated using pushover analysis, and the damage states were converted to assess the narrative drift using the values of spectrum acceleration. These values were utilized to generate fragility curves. According to the results of the investigation, the fragility function and probability distribution function might be utilized to define the damage level. The research evaluates the performance of light concrete shear walls under the influence of seismic forces

2.Models descriptions

The finite element approach is the approximate solution method to solve differential equations. In the finite element method (FEM), the whole problem is divided into pieces that represent the selected elements, in which these elements are connected by nodes. Linear seismic analysis in cases of static and dynamic loadings is being considered to analyze the RCSW. The RCSW that was adopted in the present study consists of concrete material and steel reinforcements as vertical and horizontal that are built inside the frame of a typical eight-story building. The finite element software such as SAP2000 [15] that was adopted to evaluate the performance of RCSW allows one to insert static and dynamic loadings with many options that are required in analysis. Different factors have effects on the response of a structure subjected to seismic loadings for both static and static analyses. These factors depend on the location of the building in a seismic zone. All factors are based on the Iraq seismic code [16]. Factors such as Ss and S1 for the short periods (0.2 sec) and it mapped maximum earthquake parameter at the period of 1 sec respectively with assumed damping ratio of 5%. These factors are used to calculate the parameters SMS and SM1 as follows:

SMS=SS Fa (1)

SM1=S1 FV (2)

Where

Fa= Site coefficient at short period (0.2 sec)

Fv= Site coefficient at 1.0 sec period

The values of as Ss and S1 is 0.3 and 0.1 for Baghdad city

The Fa and Fv parameters are presented in (Tables 2-2/1a and 2-2/2 b [16] Iraq seismic code 2017 respectively), in which

Fa = 0.8 and

Fv = 0.8

Design earthquake spectral response acceleration parameters SDS and $SD1$ related to 0.2 and at 1 sec period, respectively computed as follow [17]:

SDS=2/3 SMS (3)

SD1=2/3 SM1 (4)

By applying the equations mentioned above, the calculations result lists in Table (1).

Table (1): Seismic parameters calculations based on Iraq seismic code [16]

S_S	S_1	Fa	F_V	S_{MS}	S_{M1}	S_{DS}	S_{D1}
0.300	0.100	0.800	0.800	0.240	0.080	0.160	0.053

design based on the Iraq seismic code and To constrict the response spectrum curve for ASCE 7-16 [17]as follows:

$S_a=S_{DS}\,(0.4+ 0.6\ \ T\ /\ T_o)$ (5)

Equation (2.5) apply in case of $T < (0.2S_{D1}/S_{DS})$, in case of $T_o \leq T \leq T_S$, but when $T_S \leq T \leq TL$ (TL= the long-period transition period in sec.), S_a calculate as:

$S_a = S_{D1}\ /\ T$ (6)

When the period T > TL, then:

$S_a = S_{D1}\,T_1\ /\ T^2$ (7)

in which:

$T_o = 0.2\ S_{D1}\ /\ S_{DS}$ (8)

$T_S = S_{D1}\ /\ S_{DS}$ (9)

in which the values of T_O and Ts is 0.0667 and 0.3333 for reinforced concrete building with and without reinforce concrete shear walls respectively.

Element types. Different element types reused to simulates the actual performance of reinforced concrete buildings with and without RCSW as real properties of each material such as frame and area section by SAP2000 software [10]. The beams and columns simulated as FRAME section while slab and RCSW by using SHELL element. Shell element is considered to model RCEWs and slabs due to the behavior of this type of element in planar and three dimensional structures. The shell element has four nodes that are formulated so that it takes both membrane and bending behavior. Each shell element has a local coordinate system so that it defines the material properties and the applied loads such as gravity and uniform loads. The shell stiffness used four-point numerical integration in which all the unknown parameters such as stresses, foresees, and moments were found and assessed by adopting the 2x2 Gauss integration points.
Lateral loadings as seismic and wind based on the building location in Baghdad. Wind load assumed that the basic wind speed VB is 45 m/sec category B

Table 2: RCSW dimensions and mechanical properties for each material

Slab thickness above RCSWs (mm)	200	
Story height (mm), H	3000	H / W
Wall width (mm),	3000	1.00
	4000	0.75
	5000	0.6
	6000	0.5
Wall thickness (mm)	200	
Reinforcement ratio	Vertical ϕ16@150 and 200 mm c/c	
	Horizontal ϕ16@150 and 200 mm c/c	
Concrete compressive strength (fc') (MPa)	17	
	21	
	24	
Poisson's ratio (ν)	Steel 0.3	
	Concrete 0.2	
Yielding strength of the steel bars (fy) (MPa)	413	
Unit weight (γ) (kg/m^3)	Concrete 1840	
	Reinforcement 7850	

3. Proposed structural building

The proposed structural structure is detailed in the Figures (1) to (5) with dimensions of 30x30 m and a total height of 24 m, with eight floors of 3 m each. The structure was built as a slab beam system with no shear walls to resist the impacts of gravity, wind, and seismic loads as well as load combinations. The beam and column geometry dimensions are 600x400 m and 400x400 m, respectively, and the slab thickness is 200 mm at all levels. The basic load combinations based on ASCE-7-2016 [17].

Dynamic analyses – Time history linear

El Centro earthquake ground motion to evaluate the performance of reinforced concrete buildings with and without RCSW is shown in Figure (6). The peak ground accelerations (PGA) of this earthquake ground acceleration record equals to 0.295 g.

The mode superposition method is used in many structural analysis programs and is an effective way to calculate the dynamic response for the linear dynamic analysis. The accuracy of the whole structural response relies on the natural mode number and the number of modes. The applied load that is considered here changes with time with linear time history performance. The number of modes specified, which is Twelve in this case, determines the accuracy of the analysis findings.

4. Modal analysis

The first dynamic analysis is modal analysis that analyzed the whole structural buildings and the individual reinforced lightweight concrete shear walls (RLCSWs). The modal analysis without applied external load (free vibration) that is meaning the applied force as function of time is zero. Natural periods and mode shapes of vibration, which are important for any seismic analysis method .The period time based on the equation (10) as follows:

$$T=\frac{2\pi}{Wn} \qquad (10)$$

The circular frequency W_n calculated by:

$$W_n = \sqrt{\frac{K}{M}} \tag{11}$$

$$\text{Engenvalue} = (\text{circular frequence})^2 \tag{12}$$

Buildings model's analysis three buildings are analyzed under the effects of gravity loadings such as dead and live loads and an additional to wind and seismic (equivalent lateral force) and linear time history.

Table (3) Lists the model marks for whole structural buildings with and without

Building mark	Description	Analysis type
NWB	Normal weight building	Seismic-linear static and Dynamic
NWB-NWS	Normal weight building with normal weight shear Wall	Seismic-linear static and dynamic
NWB-LWS	Normal weight building With lightweight shear walls	Seismic-linear static and dynamic

These three types of buildings are modeled to check out the effective and impact of presences of reinforced concrete shear walls within the reinforced concrete building to increase the whole stiffness and reduce the deformations. Figures (1) to (5) shows the three dimensional, plane layout and elevation of reinforced concrete building with reinforced lightweight concrete shear walls with all the details. A Figure (7) and (8) presents the displacements due to seismic and time history analysis in the direction of x-axis. Tables (4) to (6) lists the modal periods, frequencies, circular frequencies and eigenvalues of 12 modes of NWB, NWB-NWS and NWB-LWS respectively. The time period of normal concrete building with lightweight concrete shear walls is between with and without reinforced concrete normal weight concrete shear walls so that the presences of lightweight shear wall contributed to reduce the time periods for all modes increase the frequency increase the circular frequency and eigenvalues. Worst case of modes is the first mode because of produced form lower circular frequency that gave more time period. Displacements become less in case of presences of RLCSWs in which the displacements are more compared with the building have normal weight reinforced concrete shear walls.

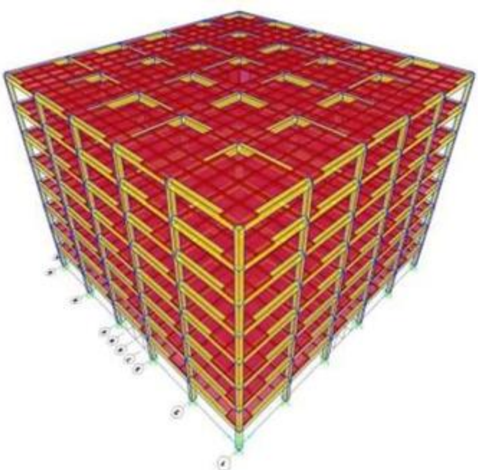

Figure (1): Whole building NWB-LWS-3D

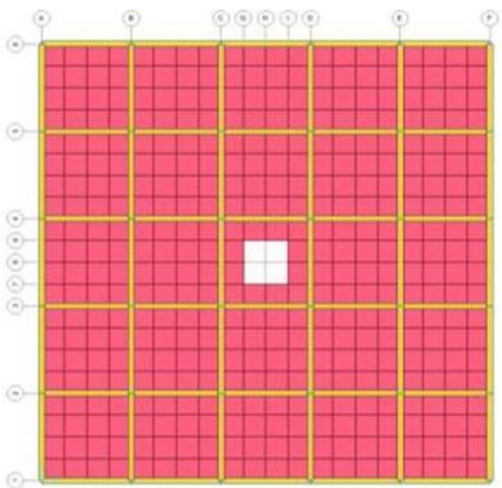

Figure (2): Whole building NWB-LWS-Top view

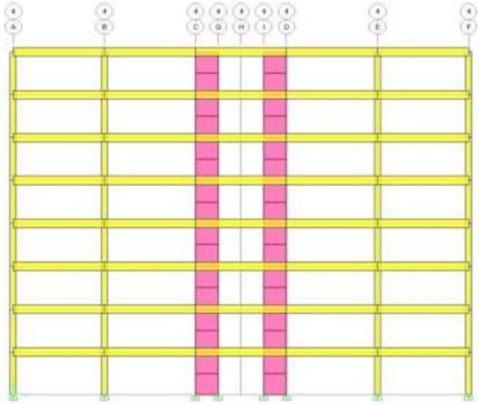

Figure (3): Whole building NWB-LWS-Elevation

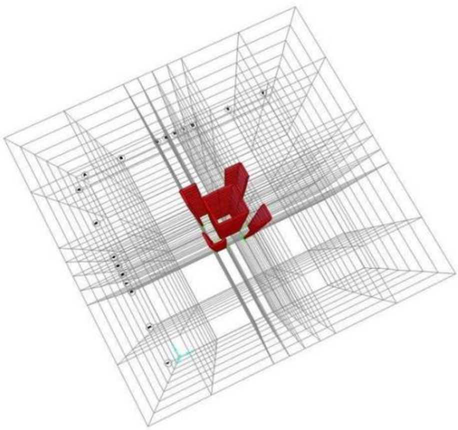

Figure (4): Top view of shear walls

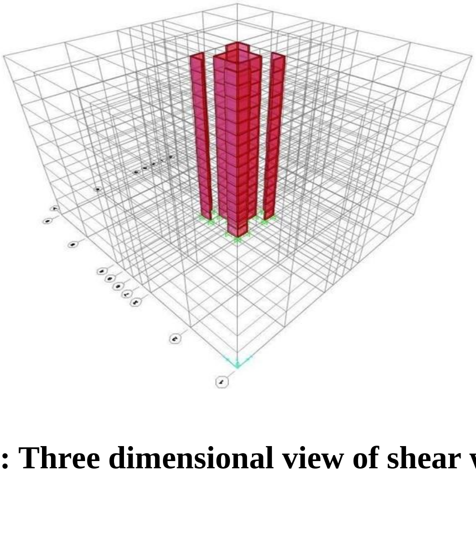

Figure (5): Three dimensional view of shear walls

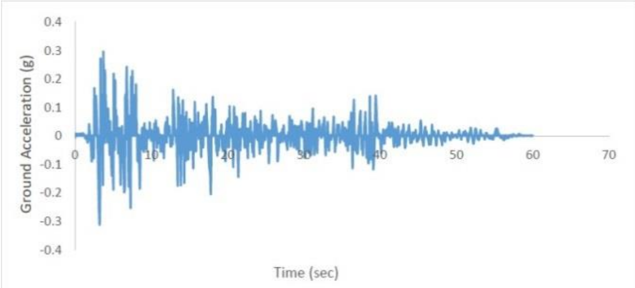

Figure (6): El Centro earthquake ground motion [15]

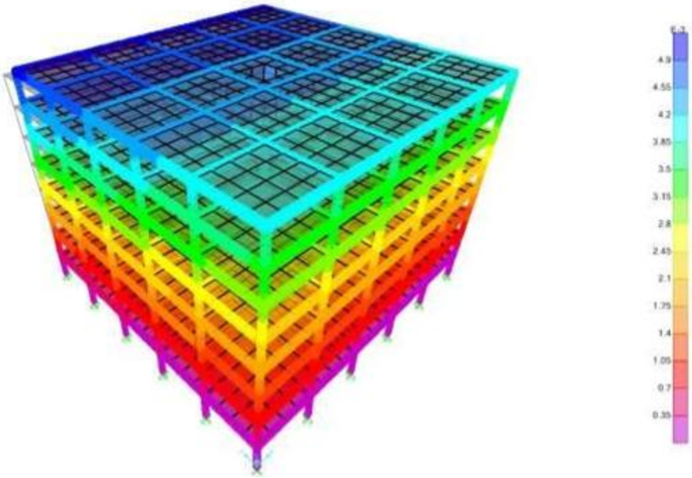

Figure (7): Displacement of whole building NWB-LWS under seismic -static load

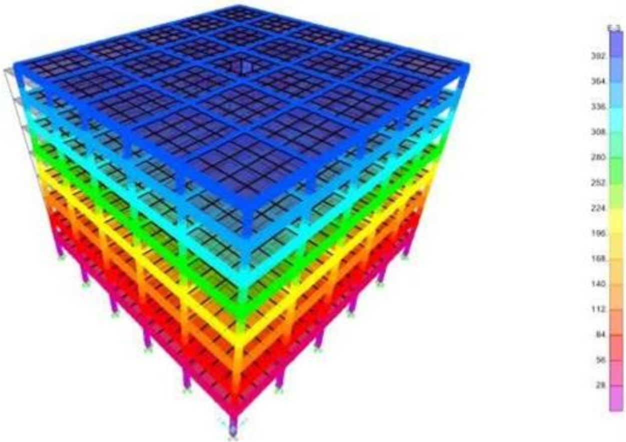

Figure (8): Displacement of whole building NWB-LWS under time history load

Table (4): Modal periods and frequencies-NWB

Step Type	Step Number	Period	Frequency	Circular Frequency	Eigen value
		Sec.	Cycle/sec	rad/sec	rad^2/sec^2
Mode	1	1.25719	0.79542279	4.99778884	24.9778932
Mode	2	1.257193	0.795422798	4.99778884	24.97789329
Mode	3	1.109036	0.901683962	5.665447419	32.09729446
Mode	4	0.417958	2.392585572	15.03305851	225.9928482
Mode	5	0.417958	2.392585572	15.03305851	225.9928482
Mode	6	0.3689	2.7107652	17.03224008	290.097202
Mode	7	0.24883	4.018811656	25.25093835	637.6098877
Mode	8	0.24883	4.018811656	25.25093835	637.6098877
Mode	9	0.220365	4.53793384	28.51267923	812.9728766
Mode	10	0.178234	5.610614601	35.25253122	1242.740958
Mode	11	0.178234	5.610614601	35.25253122	1242.740958
Mode	12	0.157743	6.339432073	39.83182646	1586.574399

Table (5): Modal periods and frequencies- NWB-NWS

Step Type	Step Number	Period	Frequency	Circular Frequency	Eigen value
		Sec	Cycle/sec	rad/sec	rad^2/sec^2
Mode	1	0.97781	1.022693974	6.42577575	41.290594
Mode	2	0.757083	1.320859059	8.299202233	68.8767577
Mode	3	0.757083	1.320859059	8.299202233	68.8767577
Mode	4	0.324788	3.07893142	19.34549666	374.248241
Mode	5	0.219692	4.551829627	28.59998903	817.9593726
Mode	6	0.219692	4.551829627	28.59998903	817.9593726
Mode	7	0.19366	5.163683668	32.44438136	1052.637882
Mode	8	0.140447	7.120110809	44.73697562	2001.396988
Mode	9	0.13838	7.226491498	45.4053852	2061.649005
Mode	10	0.137743	7.259888997	45.61522788	2080.749014
Mode	11	0.137743	7.259888997	45.61522788	2080.749014
Mode	12	0.133607	7.484625125	47.02728661	2211.565686

Table (6): Modal periods and frequencies- NWB-LWS with lightweight shear wall

Step Type	Step Number	Period	Frequency	Circular Frequency	Eigen value
		Sec	Cycle/sec	rad/sec	rad^2/sec^2
Mode	1	1.01626	0.98400	6.18263	38.22493
Mode	2	0.83393	1.19915	7.53445	56.76797
Mode	3	0.83393	1.19915	7.53445	56.76797
Mode	4	0.33760	2.96212	18.61156	346.39021
Mode	5	0.25026	3.99591	25.10705	630.36421
Mode	6	0.25026	3.99591	25.10705	630.36421
Mode	7	0.20133	4.96704	31.20886	973.99305
Mode	8	0.14386	6.95104	43.67467	1907.47710
Mode	9	0.14162	7.06110	44.36619	1968.35881
Mode	10	0.13852	7.21921	45.35966	2057.49906
Mode	11	0.13852	7.21921	45.35966	2057.49906
Mode	12	0.13387	7.46982	46.93428	2202.82648

The frequency value for structural buildings classified as high-rise buildings, such as the adopted structural building, becomes less because of this type of building higher flexibility. A Figure (9) to (14) shows the displacement, drift, and mode variations for adopted buildings. Comparisons are applied for the three buildings, Figure (9) presents the performance of displacements with building level, in which displacements increase as the height of the building high due to the load increase when the floor level become high. Building without shear walls
gave displacement higher than buildings with shear walls. Lightweight shear walls reduce the displacement but still more than the presences of normal weight shear wall due to the modulus of elasticity and mechanical properties are less than normal weight concrete. Figures (10) and (11), the lightweight concrete shear walls gave fewer seismic responses than the normal weight concrete shear walls. Drift is the ratio between the difference between displacements for each level floor and the displacements under this floor, divided by the
Floor height. The presence of RLCSWs reduces displacements so that the drift becomes less but more than the NWB-NWS. Figures (13) and (14) show the eigenvalue and frequency variations with mode. The RLCSWs within building increase the frequency so that the time period becomes less so that the damage

that occurs in the building becomes less. Table (7) lists the comparisons between the reinforced concrete buildings with and without the presence of shear walls once with normal concrete shear walls and the other with lightweight concrete shear walls. Buildings without shear walls gave displacement higher than buildings with shear walls. Because the modulus of elasticity and mechanical properties are lower than those of normal weight concrete, lightweight shear walls reduce displacement more than normal weight shear walls.

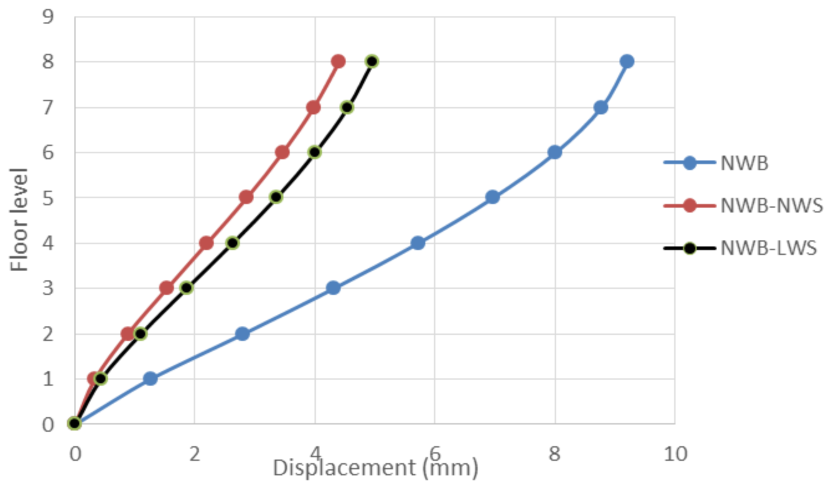

Figure (9): Displacement variations with floor level-seismic analysis

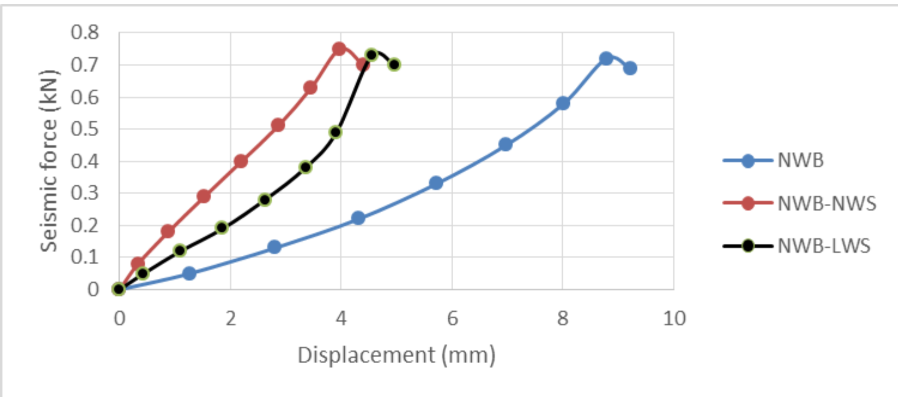

Figure (10): Seismic force-displacement-seismic analysis

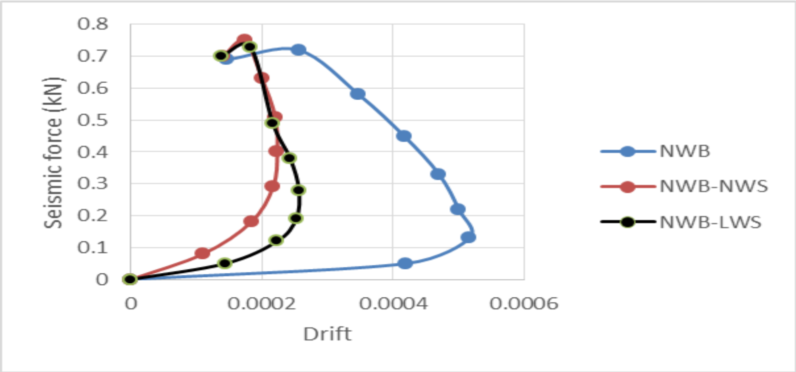

Figure (11): Seismic force-drift-seismic analysis

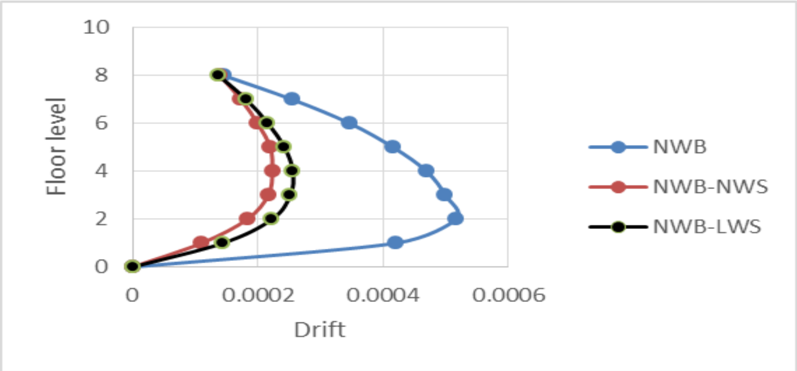

Figure (12): Drift variations with floor level-seismic analysis

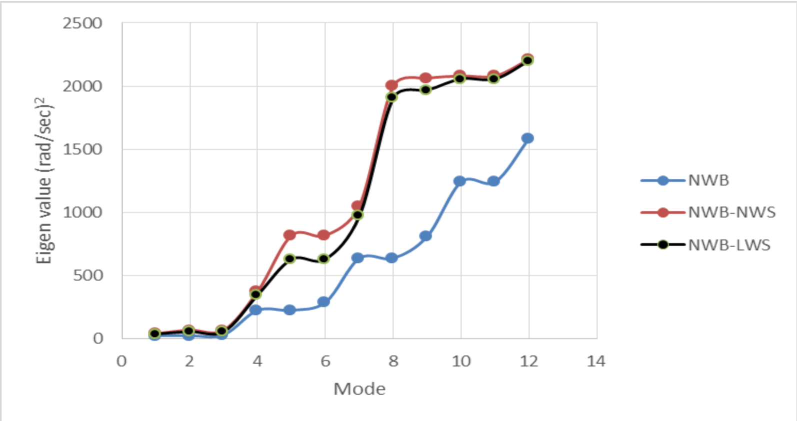

Figure (13): Eigen value variations with floor mode

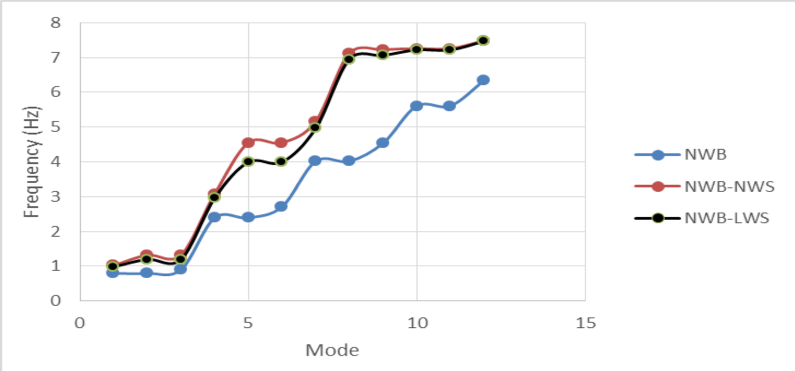

Figure (14): Frequency-mode variation

Time history linear analysis

A Figures (15) to (20) presents the performance of drift-time, strain-time, moment-rotation, displacement-time, base shear-time and base shear-displacement for reinforced concrete building without shear walls and with shear wall respectively. A Figures (21) to (26) shows the comparisons between RLCSWs and normal weight concrete shear walls within the building under the effect of time history linear analysis. Displacement, drift, strain, moment and base shear of building have RLCSWs become more than building having normal weight shear walls due to reduce in modulus of elasticity and density and an additional to mechanical properties are less.

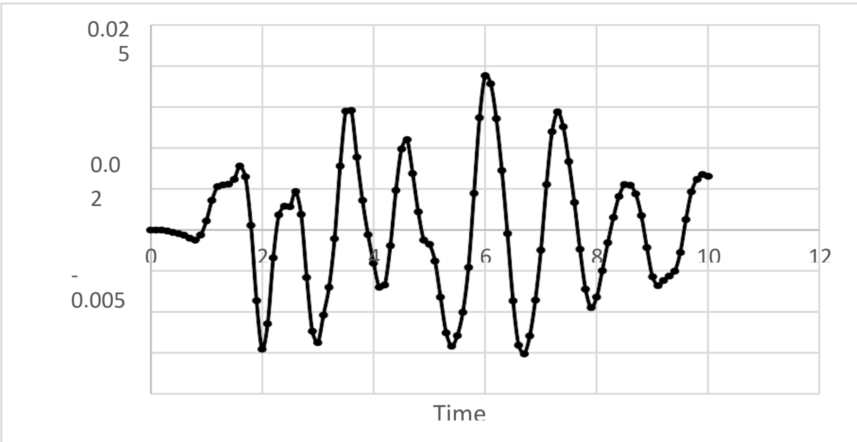

Figure (15): Drift-time performance of NWB-time history analysis

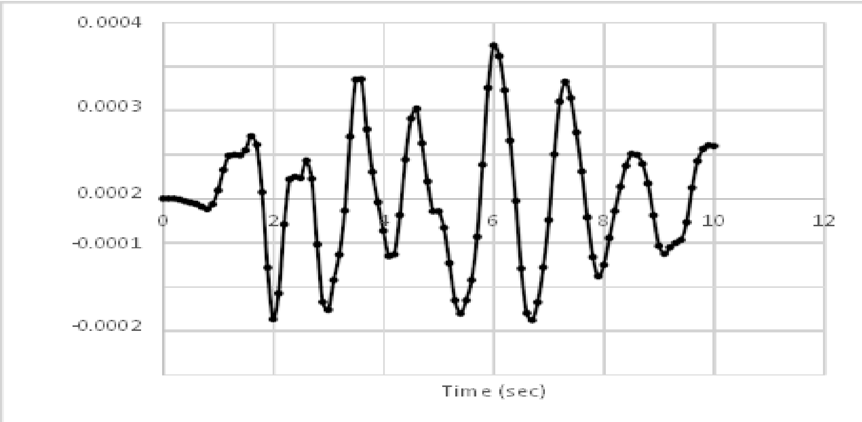

Figure (16): Strain-time performance of NWB-time history analysis

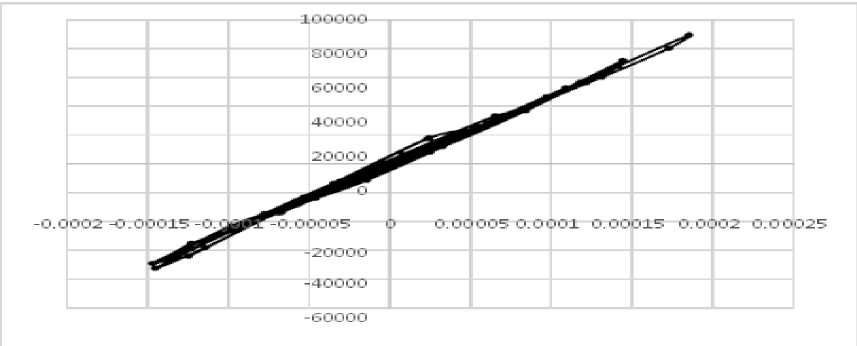

Figure (17): Moment-rotation performance of NWB-time history analysis

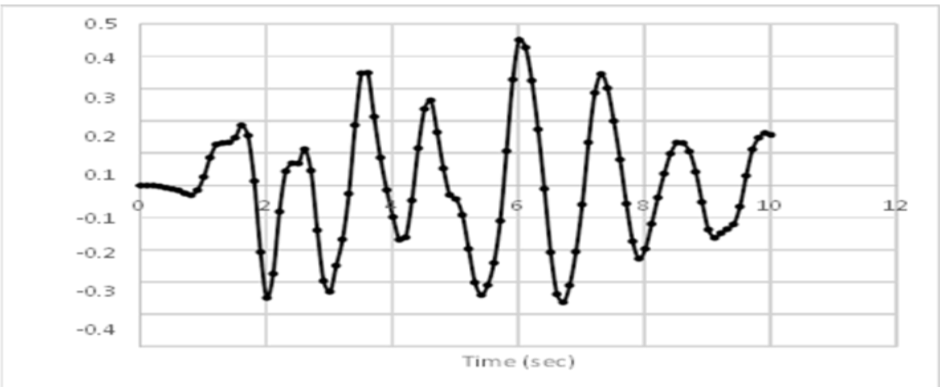

Figure (18): Displacement-time performance of NWB-time history analysis

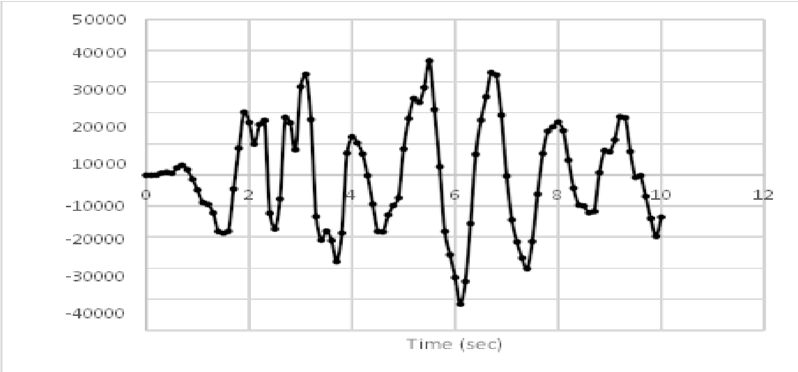

Figure (19): Base shear-time performance of NWB-time history time history analysis

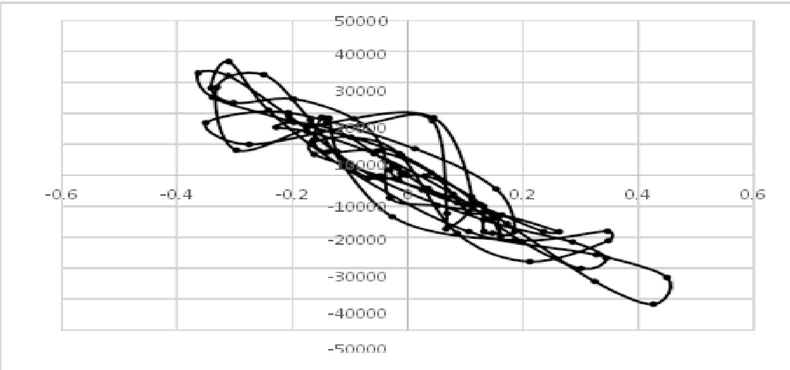

Figure (20): Base shear-displacement performance of NWB-time history analysis

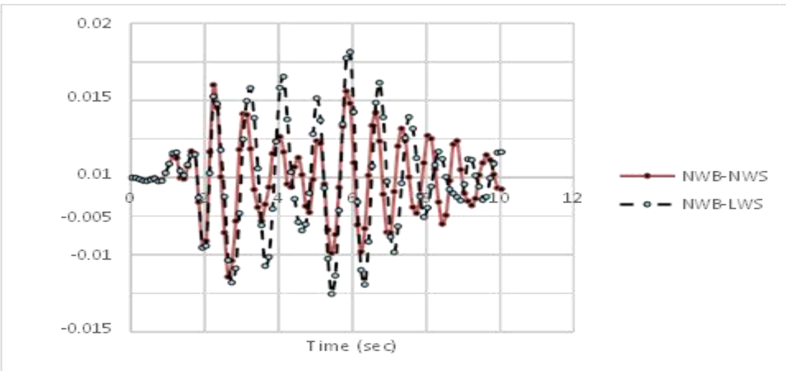

Figure (21): Drift-time performance of BWSWs-time history analysis

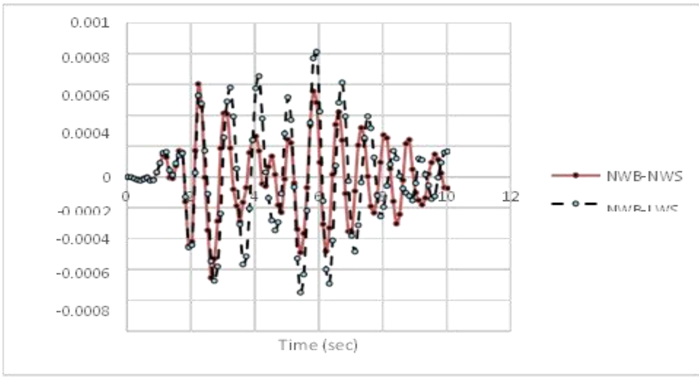

Figure (22): Strain-time performance of BWSWs- time history analysis

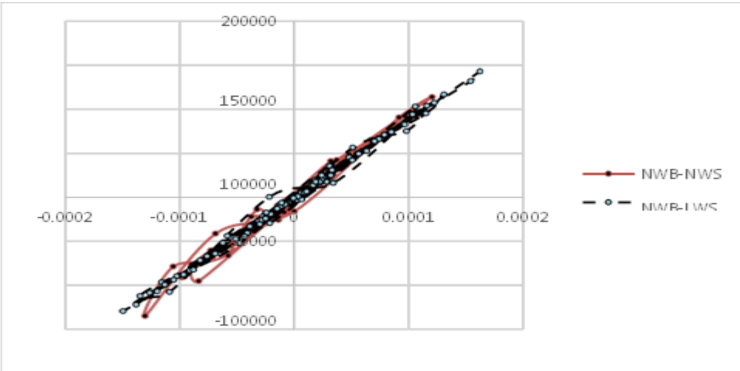

Figure (23): Moment-rotation performance of BWSWs- time history analysis

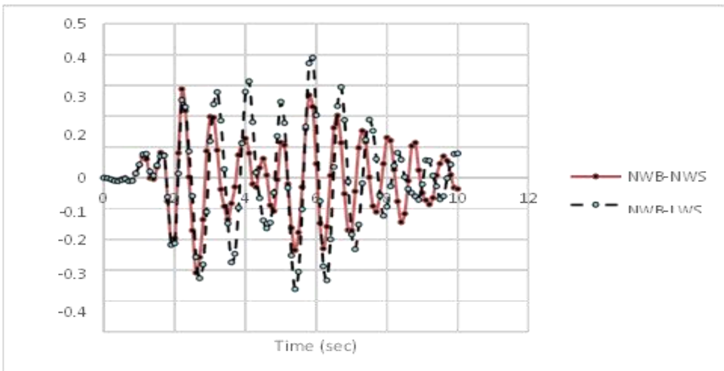

Figure (24): Displacement-time performance of BWSWs-time history analysis

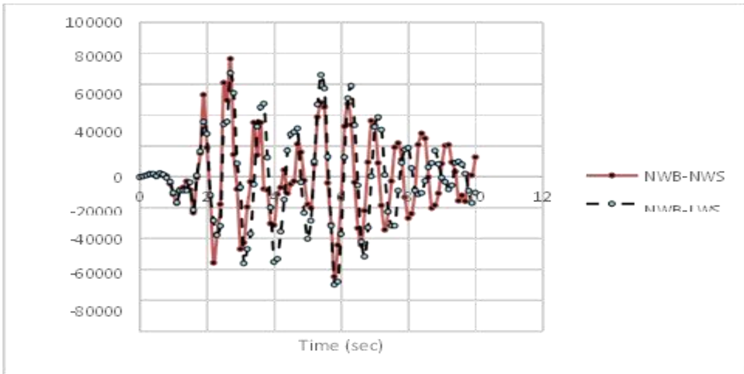

Figure (25): Base shear-time performance of BWSWs-time history analysis

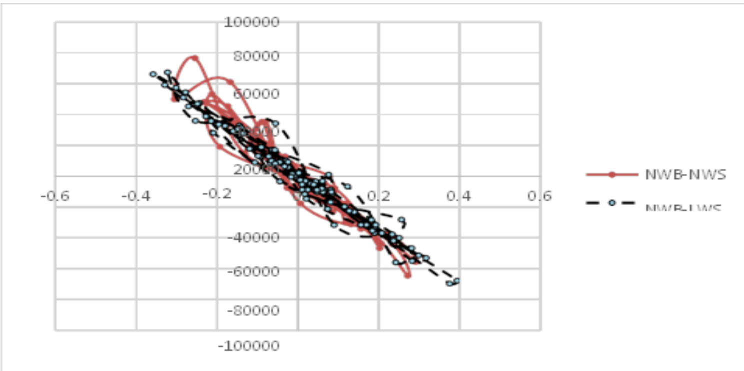

Figure (26): Base shear-displacement performance of BWSWs-time history analysis

Table (7) comparison of the resulting displacements in the buildings from the

Building mark	Static linear	Dynamic linear	%Decrease Static	%Decrease Dynamic
	Displacement (mm)	Displacement (mm)		
NWB	9.22	0.43	---	---
NWB-NWS	4.40	0.28	52.28	34.88
NWB-LWS	4.96	0.39	46.20	9.30

Analysis(Static- Dynamic)linear analysis

The seismic analysis of the structure is functionally dependent on dead load and the earthquake forces acting on it. The primary use of lightweight concrete shear walls is to reduce the dead load of a concrete structure, which results in a reduction of earthquake forces on the structure. The total dead load (self-weight) in the case of lightweight shear walls is less due to the fact that they are less dense (1840 kg/m3) compared to (2400 kg/m3) for normal concrete, so that the resisting shear force at base becomes less. Consequently, there was a percentage (19.7%) of a difference between these weights

5. Conclusions

According to the analysis results of three different structural buildings that mentioned above, conclusions are summarized as follows:

1. Displacements and drift of NWB-LWS become less(%Decrease is 46.2 under static and 9.3 under dynamic analysis respectively) when compared with that analysis results of NWB but still more than compared with the NWB-NWS.
2. Frequency of NWB-LWS gave less(On all models tested) compared with NWB-NWS that lead to make the time period become more.
3. Linear time history analysis as displacements that reflect on the drift of NWB-LWS more than NWB-NWS.
4. Base shear resistance of NWB-LWS less than NWB-NWS due to decrease in building mass(On all models tested).
5. No failure that occur due to applied static and dynamic loadings in any structural members and the maximum drift when compared with the recommended by ASCE-7-2016 [17] that equal to 288 mm.(based an ASCE 7-2016 displacement shoulde be not greater than 0.012 multiplied by the height of the building and equal to 24m)

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أداء جدران القص خفيفة الوزن على المباني الخرسانية المسلحة تحت الأحمال الزلزالية

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المستخلص: الملخص:. يتم تعريف جدار القص على أنه عنصر هيكلي رأسي ينقل أحمال الجاذبية إلى الأساس حيث يقاوم الأحمال الجانبية التي تسببها الرياح والنشاط الزلزالي.في الدراسة الحالية ، تم تقيم أداء جدران القص الخرسانية المسلحة خفيفة الوزن تحت تأثير الأحمال الزلزالية من أنواع تحميل مختلفة مثل الاحمال الاستاتيكية واجراء التحليل الساكن المكافئ والتحليل الديناميكي للتاريخ الزمني المطبق على المباني الخرسانية المسلحة مع وبدون وجود الخرسانة خفيفة الوزن المسلحة جدران القص. تتم محاكاة النماذج باستخدام طريقة العناصر المحدودة بواسطة برنامج ساب 2000 عن يتم تقييم الإزاحة ، والانجرافات ، وأداء المبنى ، والقص الأساسي لجميع حالات التحميل. أشارت نتائج التحليل إلى أن وجود جدران القص الخرسانية المسلحة أدى إلى تقليل النزوح والانحرافات وزيادة التردد تحت الحمل الزلزالي الساكن وأيضًا تقليل التشوه تحت تحميل التاريخ الزمني وزيادة إضافية في مقاومة القص القاعدية مع مزيد من الاستقرار وزيادة في الصلابة الكلية للمبنى. أيضا ، تم الاستنتاج من خلال التحليل الى ان جدران الكونكريت خفيف الووزن ضمن البناية المنوعه من الكونكريت العادي اعطت نتائج جيده ومقبوله لكن لازالت اقل من كفاءة جدران القص الكونكريت الاعتيادي .وخلال جميع مراحل التحميل لم يحصل فشل في اي جزاء من البنايات الخاضعه للفحص وحسب محددات الكود.

الكلمات المفتاحية: الكلمات الرئيسية: جدار القص الخرساني المقوى الخفيف الوزن ، التحميل الزلزالي ، التحليل الديناميكي ، SAP2000 ، تاريخ الوقت.

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