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RESEARCH ARTICLE

The behavior of the RC grouped silos under earthquake excitation according to different internal loadings

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Abstract

Reinforced concrete grouped silos-commonly employed in the industry to store granular materials- also needs to be designed in earthquake-prone areas. Silos experience a higher rate of structural failures than the majority of other types of construction. And one of the main causes of silo failure is the dynamic overpressures caused by stored materials under seismic loads. However, the principles determining loads on such structures and requirements for their structural analysis are not precisely specified in relevant codes of design. Instead of emphasizing grouped silos that interact strongly, the present dynamic design only concentrates on a single silo which can lead to unrealistic solutions for grouped silos. Therefore, it is necessary to determine the seismic behavior of grouped silos more accurately. This paper aims to investigate the seismic behavior of RC on-ground grouped silos compared to single ones by using a numerical model because of its adaptability, which allows for the analysis of a wide range of silo problems. In this context, a three-dimensional finite element model, that considered the interaction between stored material and silo wall as well as the continuity of the silo walls, was performed using ANSYS software. Two different aspect ratios and three different internal loading cases were taken into account for the parametric study to demonstrate their influences on dynamic overpressures and equivalent base shear forces in RC-grouped silos. It is concluded that designing the on-ground slender grouped silos with a high aspect ratio as individual single silos is unreasonable and may produce very low values for the base shear force.

1. Introduction

Reinforced concrete silos, either singly or in groups, are widely used in industry to store granular materials. Despite the increasing usage of silos, they are still the type of structure giving most failures in all parts of the world with large economic losses [1,2]. This means that there are a number of unanswered questions to be addressed by research that still exists to maintain their structural safety [3]. The dynamic overpressure on silo walls caused by stored materials under seismic loading is one of the main reasons for the damage and failures of such structures. Therefore, in this study seismic actions in silos, one of the high-priority research topics, is discussed in terms of grouped silos.

In comparison to single ones, the grouped silos have advantages with regard to the overall construction economy and operational efficiency. However, the grouped silo presents special problems in its structural

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analysis and design that are absent from the isolated single silo. These problems include interactions between the silo cells and interstices, the necessity to take into account thermal pressures brought on by solar heating and outside air temperature for large groups, and interactions between the silo cells and their common foundations. Therefore, the behavior of grouped silos differs from that of a single silo. Nevertheless, the individual silo cells of such groups are usually analyzed as if isolated from each other, with structural interaction being ignored [1,4].

The majority of silos are designed in line with a design code, and all design codes aim to enable a safe, functional structure to be designed and built [5]. However, the principles determining loads on grouped silos and requirements for their structural analysis are not precisely specified in relevant codes of design. ACI 313-97 [6] mentions that forces tending to separate silos of monolithically cast silo groups may occur when some cells are full and some empty and they may also result from non-uniform pressure around the circumference, thermal expansion, seismic loading, or differential foundation settlement. It also indicates that walls shall be reinforced to resist forces and bending moments due to the continuity of walls in these structures. Additionally, it refers to the effects of unsymmetrical loading of silo groups, lateral loads, and differential settlement of silos within a group on foundation, wall, and roof design. EN1998-4 [7] only propose that the condition of some silos full and some silos empty shall be considered for grouped silos, as given by ACI 313-97 [6], but they provide no guidelines to the designer.

In the literature, among the above-mentioned problems specified in the standards, bending moments due to the structural continuity in groups of reinforced concrete silos in interstice and internal loading cases are investigated mostly and many methods were offered for calculating these bending moments [1,4,8-12]. In these studies, unit strip models were used rather than complete models covering the entire heights of the grouped silos. The strip models may give satisfactory results at the pressure zone locations of greatest interest in silo design in the static state [13].

Studies on the seismic behavior of silos have recently gained momentum, especially with regard to single ones. Some experimental studies have been carried out to determine the effective stored material mass and seismic behavior of on-ground single silos until the 90s [14-19]. Along with the developments in technology, many parametric studies were performed on this subject in which stored material-silo wall interaction and/or soil-structure interaction were taken into account with numerical methods [20-27] A limited number of researchers intend to offer an analytical method for the seismic design of single silo systems, which provides quite satisfactory results, compared with the three-dimensional analysis but has the benefit of being easy to apply in the preliminary and final design stages [28-32]. However, research on the behavior of grouped silos under earthquake loading is still quite limited.

For an existing elevated steel silo group in Italy, Kanyilmaz and Castiglioni [33] studied the effectiveness of a base isolation system (curved surface sliders) by comparing the performance of the structure before and after retrofitting. Xu et al. [34] evaluated the seismic performance of elevated grouped silos, supported on a skirt extending to the ground, through the shaking table tests and the finite element analysis. They evaluated dynamic characteristics, seismic responses, cracking patterns, and failure mechanisms of the grouped silo model under empty and full conditions. Li et al. [35] performed shaking table tests and numerical analysis on an RC column-supported grouped silo and a single silo under earthquake loading to investigate the torsional effect on the seismic response of these structures with various filling conditions, empty, half, and full. And they recommend considering the torsional effect with an increase factor of 1.15. Li et al. [36] conducted an experimental study on determining dynamic horizontal pressure distribution along the height of an RC column-supported grouped silo and a single silo to provide a basis for improving the seismic design of the grouped silo structure. They indicate that the position of the silo cell is important and should be considered in the seismic design of RC column-supported grouped silos.

There is a need for more research to understand the seismic behavior of RC-grouped silos, especially those directly supported on the ground. EN1998-4, 2006 made a distinction between elevated and on-ground silos in terms of seismic behavior. The supporting structure and its ductility and energy dissipation capacity are indicated as the main concern in the seismic design of elevated silos. As for the seismic design of on-ground silos, the stresses induced in the silo wall due to the response of the stored material are emphasized as the key parameter. Thus, the goal of the current investigation is to gain information about the distribution and magnitude of dynamic overpressures on silo walls caused by stored materials in the RC on-ground grouped silos with different internal loading cases during seismic action according to two different aspect ratios. Besides this, the magnitude of equivalent base shear forces and their variation over time was also investigated.

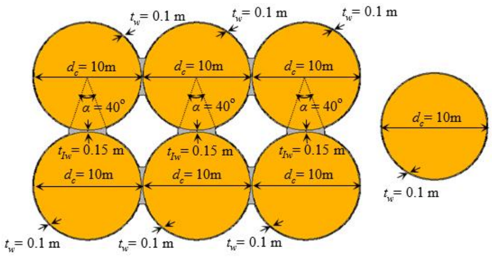
2. Geometric and material properties of the considered RC-grouped silo systems

The seismic behavior of two examples of RC flat-bottom circular grouped silos is investigated in this study in comparison with single ones with the same characteristics. The considered silos are directly supported on the ground. The geometry of the grouped and single silos of interest are shown in Fig. 1. The group of silos is composed of six circular cells of the same diameter. All cells have a diameter of $d_c = 10$ m, a wall thickness of t = 0.1m, and an intersection wall thickness of $t_{Iw} = 0.15$ m. Two different heights of H = 10 and 40 m were studied to simulate the squat and slender types of these structures.

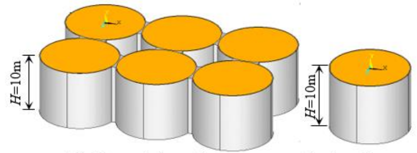
The silo wall is made of RC with Young's modulus E = 28000MPa, a unit mass $\gamma = 2500$ kg/m^3, a Poisson's ratio ν=0.2, and a damping ratio $\zeta = 5\%$. Additionally, the following material constants were assumed for the ensiled material of wheat: Young's modulus E = 5MPa, unit mass $\gamma = 900$ kg/m^3, Poisson's ratio $\nu = 0.2$, and damping ratio $\zeta = 10\%$. The grain-wall friction coefficient was also selected as $\mu = 0.57$ for wheat and RC walls [37-39].

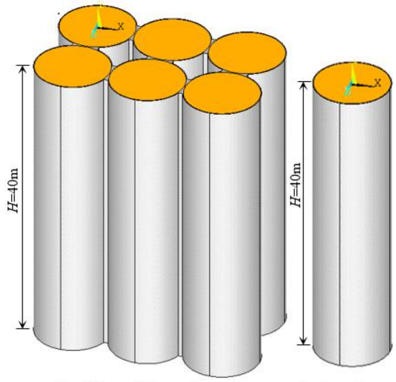
3. Considered internal loading cases for grouped silos

The combinations of loaded and unloaded circular cells in grouped silos may affect their behavior under earthquake loads. In this study three different internal loading combinations were considered as indicated in Fig. 2. Thus, the effect of loading cases on the seismic behavior of the individual circular cells of the grouped silo was investigated in comparison with the behavior of the single silo.



a) Considered silo sections

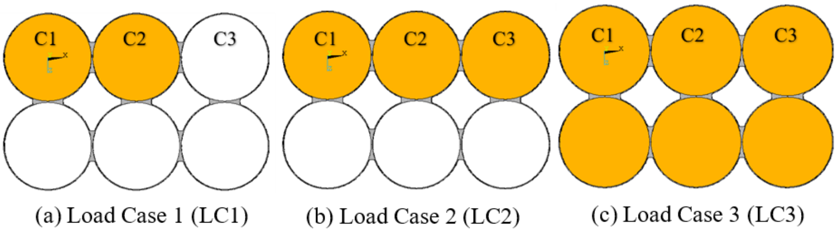




b) Considered group and single silos with H/d_c=1.0

c) Considered group and single silos with H/d_c=4.0

Fig. 1. Geometric properties of the considered systems



(a) Load Case 1 (LC1) (b) Load Case 2 (LC2) (c) Load Case 3 (LC3)

Fig. 2. Considered internal loading cases for grouped silos (a) Load Case 1 (LC1), (b) Load Case 2 (LC2), (c) Load Case 3 (LC3)

The horizontal pressures caused by stored material are loads of special interest for the design of the silo walls. In addition to static pressures, the pressure increases due to the seismic loading should also be considered in silo design. It is essential to understand the structural behavior of RC grouped silos, considering these dynamic overpressures to achieve economic and safe designs. Therefore, dynamic overpressures and equivalent base shear forces resulting from seismic loading are evaluated according to the considered internal loading cases in the following sections.

4. Finite element modeling and analysis

Silo designers have to face up quite difficult situations due to silo geometry, the complex behavior of the bulk material and its interaction with the silo walls, the filling and discharging process, or external actions such as thermal, wind, earthquake, etc. [40]. Numerical methods have been developed to overcome these difficulties impossible to solve by traditional analytical methods. In this study, the finite element method, which has gained widespread acceptance in silo research, is employed to model RC-grouped silos [41]. The three-dimensional (3D) analysis is an important tool for understanding the structural behavior of silo structures. Especially in grouped silos shell elements are inadequate to model the sudden wall thickness increase in the intersection wall regions. Therefore, solid elements are required for the correct modeling of the grouped silos because simple assumptions regarding the geometry, stiffness, and boundary conditions have not been made [11,12,42,43]. ANSYS software [44] was used to build the 3D numerical model of the considered single and grouped silo systems that take into account stored material and silo wall interaction shown in Fig. 3. The element used to represent the stored material and silo wall is SOLID185 defined by eight nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. These two components of the model were assumed to be linear elastic. A crucial step in the creation of numerical models for silos is the interaction between the silo wall and the stored material. That interaction was described by the well-known Coulomb's friction model. Since the cohesion sliding resistance between the silo wall and wheat is assumed to be zero, the wall friction coefficient, μ, is the only parameter required. The surface-to-surface contact model, the most appropriate model for 3D silo analysis, was used between the silo wall and wheat. CONTA174 and TARGET170 elements were assigned to the outer surface of the wheat and the inner surface of the silo wall, respectively. The contact condition between these two components is routinely determined at the Gauss integration points [45].

A full transient dynamic analysis was performed considering Rayleigh damping. The developed finite element model includes the nonlinearity of the contact between the stored material and the silo wall. This solution is nonlinear because the area of contact may change as the load is applied. The only load established in the model was the seismic load. The NS component of the Yarımca station, 1999 İzmit earthquake, was applied to the structure in the x direction shown in Fig. 3. Acceleration time histories of the Yarımca ground motions are given in Fig. 4.

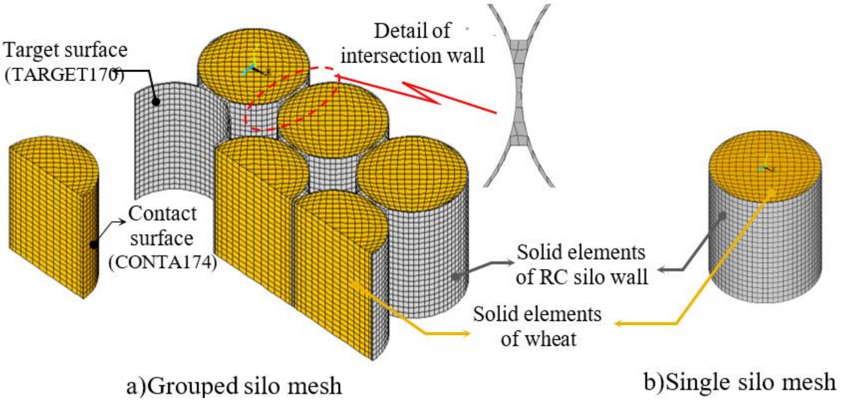


Fig. 3. Finite element model for silos (a) Grouped silo mesh, (b) Single silo mesh

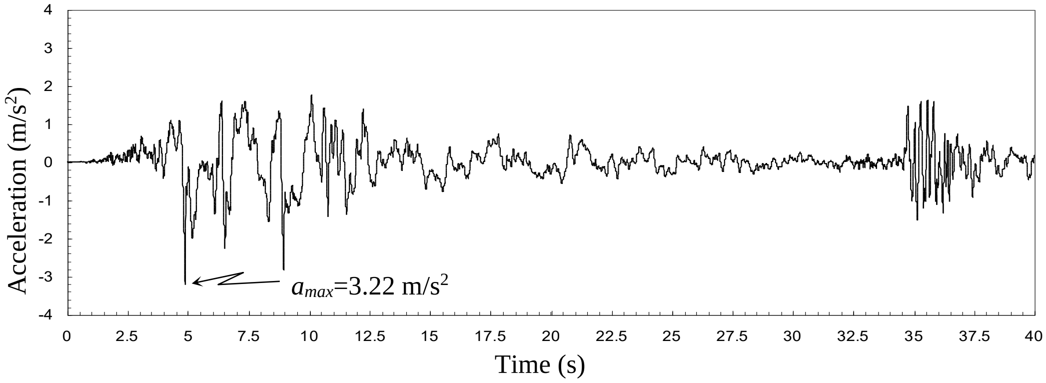


Fig. 4. Acceleration time history of the ground motions: Yarımca Station NS component

5. Results and discussion

The results of a performed parametric study performed were presented here to enhance the understanding of the seismic behavior of grouped silos. Two different aspect ratios ($H/d_c = 1.0$, and 4.0) and three different internal loading cases named LC1, LC2, and LC3 were considered in this study. The results obtained for grouped silos (GS) were compared with those obtained for single silos (SS) concerning dynamic overpressures and equivalent base shear forces. In these comparisons C1, C2, and C3 expressions were used to define silo cells with numbers as shown in Fig. 2. Left and right side terms are used to express the opposed walls in the *x* direction, which is the direction of the seismic load.

5.1. Dynamic overpressures

The obtained maximum dynamic overpressures and their time of occurrence on opposed walls of cells C1, C2, and C3 for loading case 3 (LC3) and on opposed walls of cell C1 for three different loading cases (LC1, LC2, and LC3) in grouped silos as well as that values on opposed walls of single silos for aspect ratios of 1.0 and 4.0 are given in Table 1, respectively. To comprehend, the maximum dynamic overpressures on opposed walls of cells C1, C2, and C3 in grouped silo for loading case 3, LC3, are given in Fig. 5, comparatively for aspect ratios of 1.0 and 4.0.

Table 1. Maximum dynamic overpressures and their occurrence times on opposed walls of the considered grouped silo cells and single silos

		$H/d_c = 1.0$				$H/d_c = 4.0$			
		Left side		Right side		Left side		Right side	
Grouped Silos		t (s)	p_{hs}^{max} (kN/m^2)	t	p_{hs}^{max}	t	p_{hs}^{max}	t	p_{hs}^{max}
Load Case 3	C1	7.0	22.8	9.0	39.3	7.0	21.1	9.0	34.2
	C2	7.0	24.3	9.0	38.9	7.0	23.5	9.0	33.9
	C3	7.0	24.3	9.0	35.8	7.0	23.7	9.0	32.7
Silo Cell 1	LC1	7.0	24.8	9.0	42.3	7.0	21.0	9.0	36.4
	LC2	7.0	24.7	9.0	42.3	7.0	21.6	9.0	35.9
	LC3	7.0	22.8	9.0	39.3	7.0	21.1	9.0	34.2
Single Silos		6.9	24.5	8.9	38.2	7.3	22.2	4.85	32.0

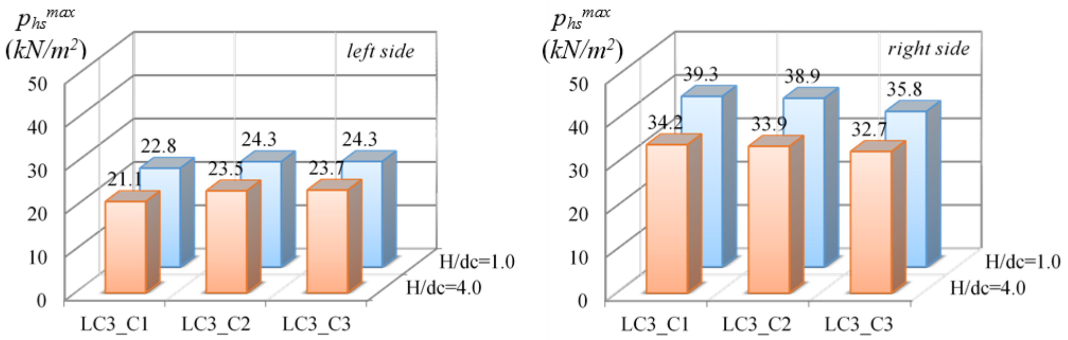
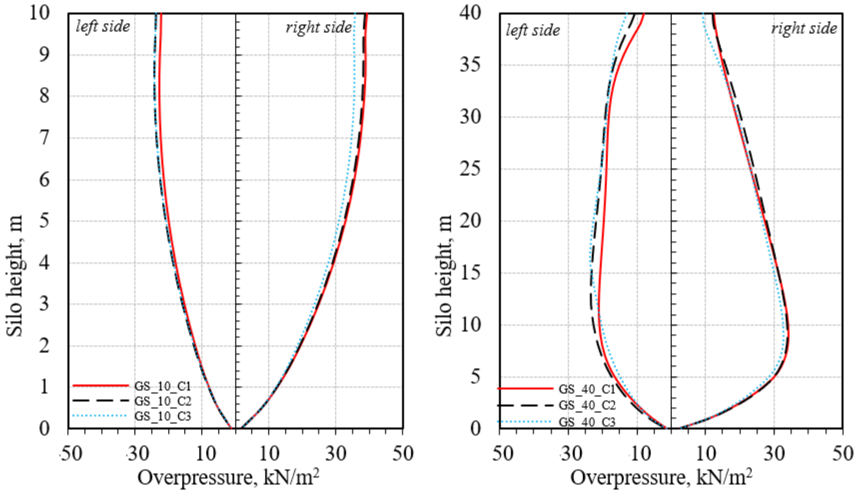


Fig. 5. The maximum dynamic overpressures on the opposed walls of cells for loading case 3 in grouped silo under seismic loading for aspect ratios of $H/d_c = 1.0$ and $H/d_c = 4.0$

Due to the defined contact between the stored material and the wall, which allows the independent movement of the bulk material from the silo wall to be taken into account, different overpressure values were obtained on the opposed walls of the silos. In LC3, which symbolizes the case of the grouped silo being full, while similar overpressure results were obtained for C2 and C3 on the left wall, C1 gives 7 % less overpressure value for an aspect ratio of 1.0 and 12 % less overpressure value for aspect ratio of 4.0 than C2 and C3. As for the right side, while similar overpressure results were obtained for C1 and C2, C3 gives 10 % less overpressure value for an aspect ratio of 1.0 and 5 % less overpressure value for an aspect ratio of 4.0 than C1 and C2.

For the situation in question, the variation of the dynamic overpressures over the height of the cells can be examined from Fig. 6 and it is seen that the cells in a grouped silo exhibit quite similar behavior in overpressure distribution. Therefore, it can be said that the position of the silo cells has a minor effect on the magnitude of dynamic overpressure results and their distribution along the height of the silo cell for on-ground squat and slender grouped silos.

Fig. 7 displays the maximum dynamic overpressures on opposed walls of cell C1 for three different loading cases, LC1, LC2, and LC3, in grouped silos and the values on opposed walls of single silos, comparatively for aspect ratios of 1.0 and 4.0.



(a) H/d_c=1.0 (b) H/d_c=4.0

Fig. 6. Comparisons of the dynamic overpressure distributions over the height of the opposed walls of cells for loading case 3 in grouped silos under seismic loading for aspect ratios of $H/d_c = 1.0$ and $H/d_c = 4.0$

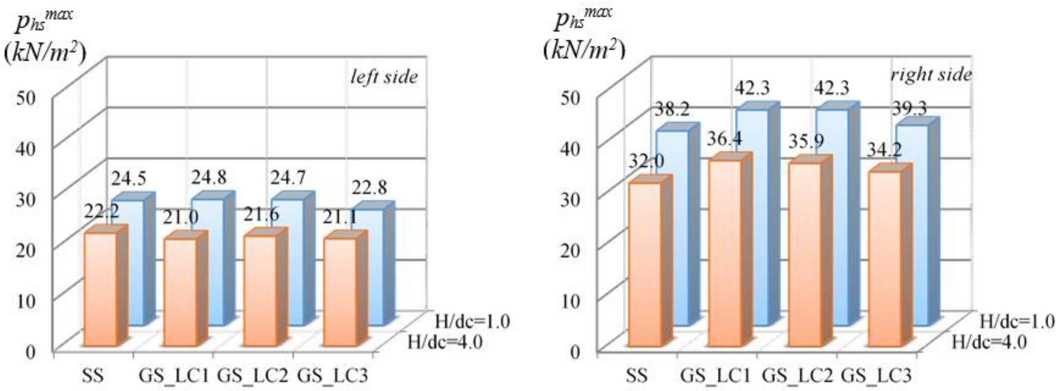


Fig. 7. The maximum dynamic overpressures on opposed walls of cell C1 for three different loading cases in grouped silos and single silos with aspect ratios of 1.0 and 4.0

In LC1 representing the situation of only the first two adjacent cells being full, and LC2 representing one of only the first three adjacent cells being full in the earthquake direction, the same overpressure values were obtained for cell C1 on both left and right sides of the wall for all aspect ratios. As for LC3, which represents the situation that all cells are full, for all aspect ratios, around %7 fewer overpressure values were obtained on the left and right sides of the wall than LC1 and LC2. When a comparison is made for a single silo, it is seen that it gives around 10% lower overpressure value on the right side compared to LC1 for all aspect ratios. The maximum dynamic overpressures obtained for all loading cases in grouped silos and for the full single silo were almost the same, but the single silo gives slightly smaller overpressure values than grouped silo cells on the right side of the wall.

Comparisons of the dynamic overpressure distributions over the height of the opposed walls of cell C1 for three different loading cases (LC1, LC2, and LC3) in grouped silos and single silos under seismic loading for aspect ratios of 1.0 and 4.0 are given in Fig.8.

As can be seen from Fig. 8, especially for the squat silo with an aspect ratio of 1.0, the overpressure distribution along the height almost overlaps both on opposed sides of the cell for all considered loading cases in grouped and single silos. As for the slender silo with an aspect ratio of 4.0, the distribution is similar for all loading cases on both sides of the cell, and the overpressures are reduced in the upper parts of the silo cells due to increased slenderness. This reduction gets more pronounced as the fill rate of the grouped silo rises. When the distribution is examined for the slender single silo, it is seen that the overpressure values along the height of the silo wall are generally smaller than those for the grouped silos. Especially in the upper parts, about 1/4 of the height of the silo, the overpressure is zero due to the separation between the stored material and the wall, which is allowed in finite element modeling. Similar behavior is not obtained in grouped silos. Observations revealed that as for slender grouped silos magnitudes and the distribution of the overpressures along the silo, cell height is different from single silos. So the structural analysis of a slender grouped silo should consider a realistic behavioral model of the interconnected cylindrical silo cells. Since the base shear forces might be affected by the variation in overpressure distribution along the height, this circumstance will be discussed separately below.

5.2. Equivalent base shear force

The force that occurs along the silo walls' unit width is represented by the equivalent base shear, which shares the same behavior and characteristics as the total base shear force. It is important to note that these reactions were derived from the dynamic overpressure distributions over the height of the silo for each time step and the equivalent base shear was selected at the time step that produces the greatest resultant force. The obtained maximum values and occurrence times for the equivalent base shear force on opposed walls of cells C1, C2, and C3 for loading case 3 (LC3) and on opposed walls of cell C1 for three different loading cases (LC1, LC2, and LC3) in grouped silos, as well as that values on opposed walls of single silos for aspect ratios of 1.0 and 4.0, are given in Table 2, respectively.

In the full case of the grouped silo, the variations of equivalent base shear forces in time at opposed sides of the cells in the earthquake direction are given for the aspect ratio of 1.0 and 4.0 in Figs 9, and 10 respectively. The obtained maximum values of this parameter and their occurrence instants are different for both sides of the cells due to the defined contact between bulk material and silo wall. When the group silo is full, the maximum equivalent base shear force values on the walls are reached simultaneously within the three cells, as shown in Figs. 9 and 10, and these values are almost identical. From this, it can be said that cells in the fully loaded grouped silos have similar seismic behavior.

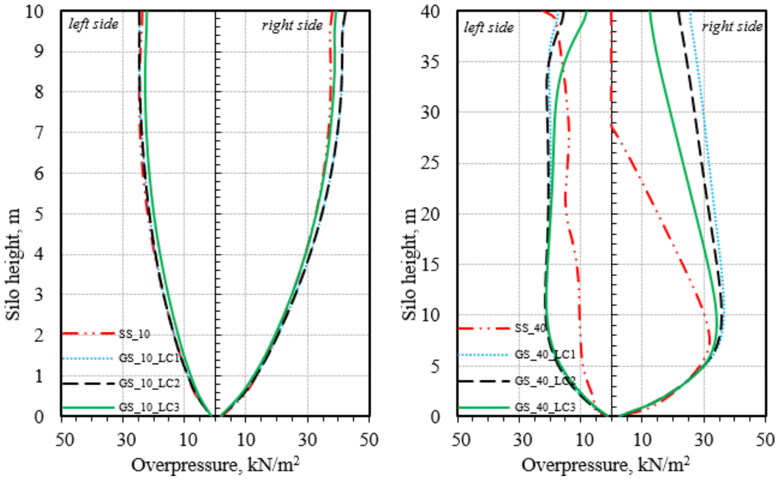


Fig. 8. Comparisons of the dynamic overpressure distributions over the height of the opposed walls of cell C1 for three different loading cases in grouped silos and single silos under seismic loading for aspect ratios of (a) $H/d_c = 1.0$ and (b) $H/d_c = 4.0$

Table 2. Maximum equivalent base shear forces and their occurrence times on opposed walls of the considered grouped silo cells and single silos

		$H/d_c = 1.0$				$H/d_c = 4.0$			
		Left side		Right side		Left side		Right side	
Grouped Silos		t (s)	V_e^{max} (kN/m)	t	V_e^{max}	t	V_e^{max}	t	V_e^{max}
Load Case 3	C1	7.0	174.4	9.0	290.9	7.0	683.2	9.0	957.9
	C2	7.0	183.3	9.0	288.3	7.0	754.3	9.0	970.6
	C3	7.0	182.9	9.0	272.5	7.0	740.5	9.0	916.7
Silo Cell 1	LC1	7.0	190.0	9.0	308.0	7.0	748.6	9.0	1211.8
	LC2	7.0	189.8	9.0	307.8	7.0	767.6	9.0	1146.3
	LC3	7.0	174.4	9.0	290.9	7.0	683.2	9.0	957.9
Single Silos		6.9	190.0	8.9	288.7	7.3	503.1	4.85	552.9

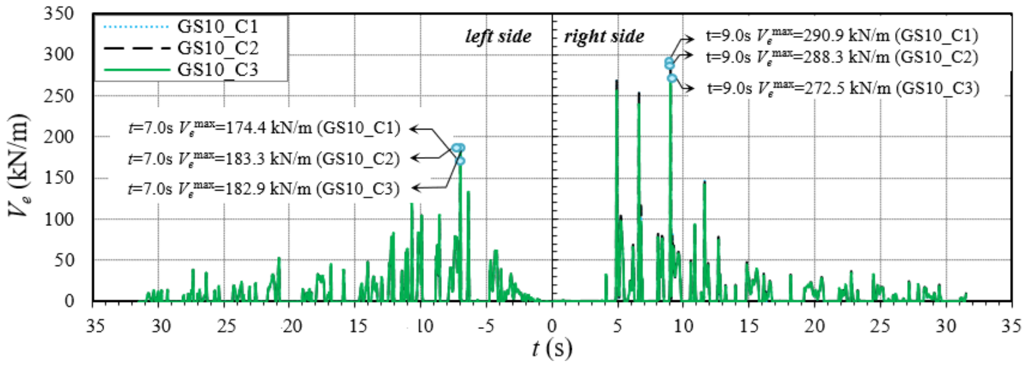


Fig. 9. Variations of equivalent base shears in time at opposed sides of the cells in the earthquake direction for loading case 3 in grouped silos with an aspect ratio of 1.0

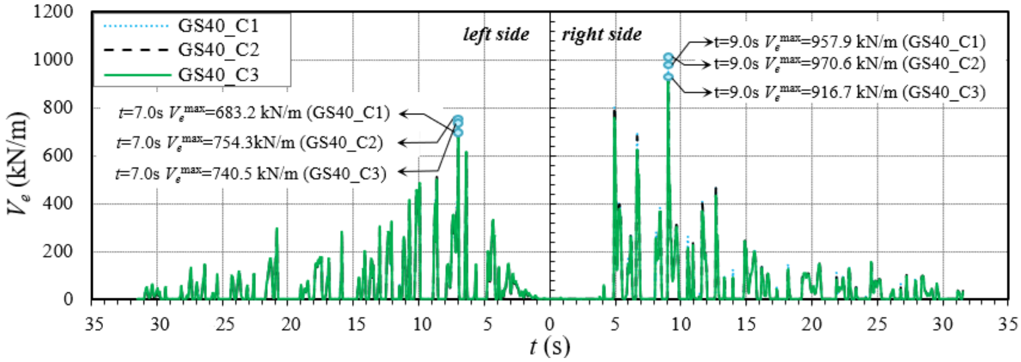


Fig. 10. Variations of equivalent base shears in time at opposed sides of the cells in the earthquake direction for loading case 3 in grouped silos with aspect ratio of 4.0

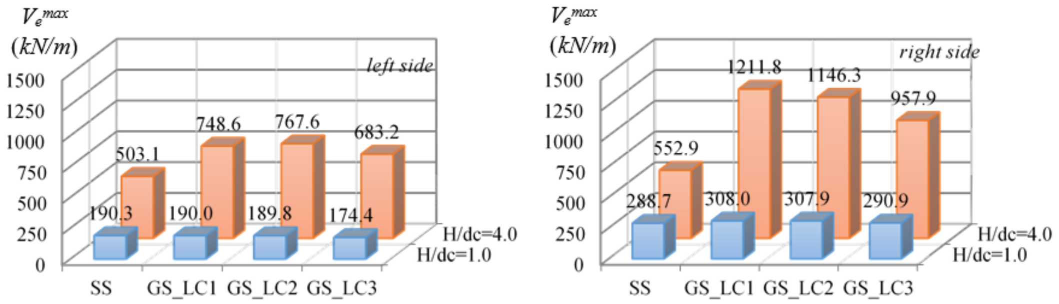


Fig. 11. The maximum equivalent base shears on opposed walls of cell C1 for three different loading cases in grouped silos and single silos with aspect ratios of 1.0 and 4.0

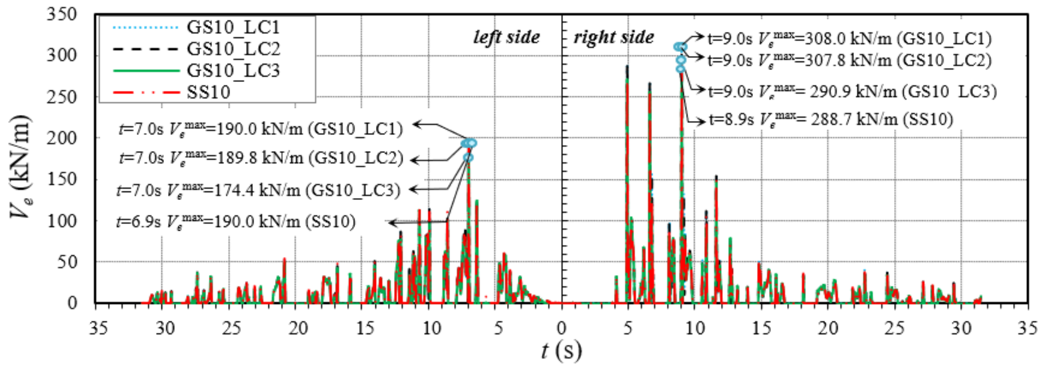


Fig. 12. Temporal variations of equivalent base shears at opposed sides of the cell, C1 in the earthquake direction for three different loading cases in grouped and single silos with an aspect ratio of 1.0

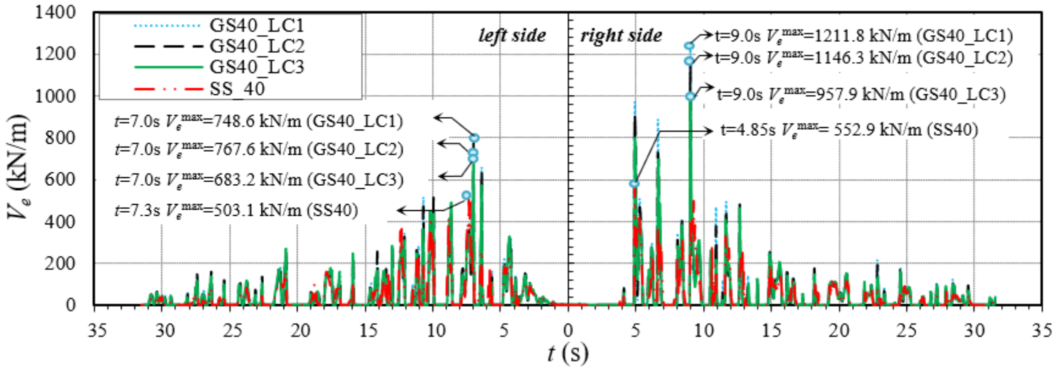


Fig. 13. Temporal variations of equivalent base shears at opposed sides of the cell, C1 in the earthquake direction for three different loading cases in grouped and single silos with an aspect ratio of 4.0

The obtained maximum equivalent base shears on opposed walls of cell C1 for the loading cases, LC1, LC2, and LC3 in grouped silos and single silos with aspect ratios of 1.0 and 4.0 are given in Fig. 11 and their variations in time are depicted in Figs. 12 and 13, comparatively.

As Fig. 11 demonstrates, the equivalent base shear forces at both sides of cell C1 were obtained as very similar, for three different loading conditions in the grouped silo with an aspect ratio of 1.0. There was a difference of around 7% between the LC1 and LC3 loading conditions on both sides. When the results obtained for the single silo and the grouped silo are compared, it is seen that the results are almost the same but the single silo gives little small result on the right side. As a result, individual single silos can represent on-ground squat-grouped silos closely in terms of base shear force.

When the findings are examined for the aspect ratio of 4.0, it is seen that different loading conditions affected the obtained equivalent base shear values, especially for the right side of cell C1 in the grouped silos. On the right side of cell C1, LC3 gave a 21% smaller value of equivalent base shear than LC1. Besides, the obtained equivalent base shear force values for the grouped silo are much larger than those obtained for the single silo for an aspect ratio of 4.0. The equivalent base shear in cell C1 of the grouped silo was 53% larger on the left side and 119% larger on the right side when compared to the single silo. From this, it can be concluded that designing the slender grouped silos with a high aspect ratio as individual silo cells may produce very low values for the base shear force.

When the obtained variations of the equivalent base shear forces in time for grouped silos with various loading cases are evaluated, the maximal response values were obtained at 7.0 sec as 174~768 kN/m at the left side and 9. sec as 290~1212 kN/m at the right side of the silo wall for the considered aspect ratios of 1.0 and 4.0. Therefore, for the considered aspect ratios, similar behavior was observed in the grouped silos in different loading conditions, and the difference only occurs between the squat and slender ones in terms of the maximum response values.

However, the maximal response value for a single silo with an aspect ratio of 1.0 occurred at 6.9 seconds as 190.0 kN/m on the left side and at 8.9 seconds as 288.7 kN/m on the right side of the silo wall. For the aspect ratio of 4.0, the maximal response value for a single silo was achieved at 7.3 seconds as 503.1 kN/m on the left side and 4.85 seconds as 552.9 kN/m on the right side of the silo wall. As it can be understood from Figs. 12 and 13 that behaviors obtained for single and grouped silos with an aspect ratio of 1.0 are practically overlapped. For an aspect ratio of 4.0, a significant difference between single and grouped silo behaviors started to appear.

6. Conclusions

The problem of RC grouped silos, which are circular in plan and directly supported on-ground, subjected to earthquake loading has been studied. A three-dimensional finite element method was used to explore the seismic behavior of grouped silos compared to single ones. Thus, it is aimed to determine the validity of the analysis of grouped silos as discrete single silos in the literature. Additionally, different stored material internal loading cases are investigated parametrically to understand their effects on the seismic behavior of grouped silos in terms of dynamic material overpressures and equivalent base shear forces. To represent the squat and slender types of silos, two different aspect ratios were considered within the scope of the paper. Based on the results of this study, it is possible to deduce the following conclusions:

In the fully loaded case, the seismic behavior of silo cells is similar and the position of the cells has no appreciable effect on the magnitudes of dynamic overpressures and equivalent base shear forces for on-ground squat and slender grouped silos.

For different loading conditions, the height-wise distribution of dynamic overpressures almost overlaps both on opposed sides of the cell in on-ground squat-grouped silos. As for the slender ones, the distribution is similar for all loading cases on both sides of the cell, and the overpressures are reduced in the upper parts of the silo cells due to increased slenderness. The magnitudes of dynamic overpressures and equivalent base shears on both sides of squat and slender silos tend to decrease with increasing filling rates, especially since this decrease is more evident for slender silos in terms of base shear force.

The seismic behavior of on-ground single and grouped silos practically overlapped for squat types. A significant difference between single and grouped silo behaviors started to appear for slender types. The magnitudes, height-wise variations, and the peak value occurrence instants of the related terms of overpressure and base shear differ from those for single ones. So that designing the slender grouped silos with a high aspect ratio as individual single silos is unreasonable and may produce very low values for the base shear force. The structural analysis of a slender on-ground grouped silo should take a realistic behavioral model of the interconnected cylindrical silo cells.

It should be noted that the conclusions are valid for the considered silo models under the ground motion used in this study. Further research on this topic should be conducted using various aspect ratios and ground motions to generalize these findings.

Conflict of interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Data availability statement

The data presented in this study are available upon request from the corresponding author.

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