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RESEARCH ARTICLE

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The effect of foundation type selection on approximate cost of reinforced concrete buildings: the role of soil classes and number of floors

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Abstract

This study investigates the choice of foundation type, which is one of the factors affecting the approximate cost of rough construction of buildings with reinforced concrete structural systems. In the study, isolated, continuous and raft foundation types are discussed comparatively for buildings with different numbers of floors (1-4 floors above the basement) and different soil classes (ZB-ZE). In the literature, there is no study in which the effects of foundation type, number of floors and soil classes on the approximate cost of a building are analyzed together. This study aims to fill this gap in this field. Reinforced concrete design and analysis were performed using Protastructure 2022 software; concrete, formwork and reinforcing steel quantities were calculated, and approximate costs were calculated with the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change 2024 Construction and Installation Unit Prices (TCÇŞİDB 2024) and the results were presented in tables and graphs. According to the study's findings, as the soil class improves, isolated foundations are more economical than other foundations. In contrast, the cost of isolated foundations increases significantly as the soil class deteriorates and the number of floors increases, while the cost difference between continuous foundation and raft foundation decreases.

Keywords: Foundation type selection; Approximate cost, Soil classes, Number of floors, Cost analysis

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1. Introduction

The construction sector is one of the essential sectors for the development and sustainability of modern societies. It is an important source of economic growth and employment while enabling the realization of infrastructure and superstructure projects that affect daily life. Completing construction projects requires intensive efforts from engineers and other industry stakeholders. All processes are critical in this context, from the initial design phase of construction projects to the final turnkey delivery. Safety, aesthetics, and economy are the most important principles to consider during the design phase of construction projects. Especially in the design of structural bearing systems, the most critical factor is safety, but cost is also an important consideration in engineering practice [1]. The cost of a project starts with the cost of the land on which the project will be realized and ends with the completion and delivery of the entire construction. These costs can generally be grouped as land costs, costs incurred for plans, projects and permits, rough construction costs and acceptable construction costs.

Rough construction is an early phase of the construction project, focusing on durability and structural integrity rather than visual aesthetics. Notably, the cost of the rough construction part, where the manufacturing of support systems is done, is a significant component of a construction project's total cost. Generally, the share of rough construction within the total cost of a construction project can vary significantly from project to project. Many variables, from the size and complexity of the project to the condition of the support system, soil characteristics, and materials used, influence the cost of rough construction. For example, interior design and materials may carry more weight in a luxury housing project. In contrast, in an industrial facility project, the rough construction cost may constitute a more significant percentage of the total cost.

The primary aim of this study is to thoroughly examine the impact of different types of surface foundations on the approximate cost of rough construction for single and multi-story reinforced concrete-bearing system buildings with basements. As known, the most crucial task of foundations in structures is to safely transfer the loads from the superstructure and any other potential forces that may arise to the ground. The choice of foundation type is not only dependent on the superstructure but also heavily relies on the condition of the soil. Therefore, the class of soil on which the structure will be established, and its physical properties are significant factors that influence the choice of foundation type.

Foundations can generally be divided into two main groups: shallow and deep. As the name suggests, the shallow foundations discussed in this study are those established closer to the ground surface. The types of foundations used in this study have been selected as isolated (pad), continuous (strip), and raft (mat) foundations, per market conditions. Understanding the impact of these foundation types on the rough construction cost of a building, especially under different soil conditions, is crucial for the cost estimates and budget planning of construction projects. The rough construction cost includes the concrete, construction steel, and formwork quantity and expenses used to construct the building's support system. This study will address these elements in detail, providing cost analyses for different foundation types, total building heights, number of floors, and different soil classes.

Türkmen and Tekeli [2] and Türkmen et al. [3] examined the cost variations of reinforced concrete buildings with 4-8 floors and a standard floor plan of 248 m², conducting static and reinforced concrete designs for buildings with two apartments per floor in earthquake-prone and non-earthquake-prone areas, with and without irregularities, and for different soil types. Their research, conducted using the Probina Orion 2000 software and the equivalent static earthquake load method, found that the additional load imposed by earthquake-resistant design increased the total cost by only 4-8%. Through regression analysis, Dorum et al. [4] explored the variations in rough construction costs for reinforced concrete buildings depending on soil class and earthquake zone, highlighting the differences between soil classes and earthquake zones per the 1998 Turkish Regulation on Buildings to be Constructed in Disaster Areas. Dikmen and Özek [5] investigated the effect of soil classes on the cost of industrial-type buildings with different column spacings. The designs of single-story buildings with varying support systems were compared based on approximate costs for different soil classes according to the 2007 Turkish Earthquake Regulation. Azimi et al. [1] analyzed the cost of reinforced concrete support systems for buildings with varying numbers of floors and soil types using acceleration spectra. They found a significant cost difference in buildings designed with 5 floors as the soil structure became more stable. Eroğlu and İpek [6] examined the effects of soil class and different foundation types (isolated, continuous, and raft foundations) on structural behavior. Focusing on the interaction between soil and structure, their research aimed at decision-making regarding foundation systems relative to soil, considering soil classes and the requirements of the 2018 Turkish Building Earthquake Code (TBDY), with supporting system designs completed using the IDE-CAD software.

The number of floors in a building type is significant for construction costs. In a study that changed only the building geometry while keeping the floor areas constant, structural designs using the tunnel form system demonstrated the effect of both the number of floors and building height on costs, showing that the cost per area decreases up to a certain number of floors, particularly after 15 floors, the unit cost increases [7]. Another study on the effect of soil classes on foundation design costs, particularly for buildings on soils with different sand densities, was conducted by Azhim and Prakoso [8]. Their research in various cities in Indonesia revealed that the soil's friction angle and elasticity modulus were the primary factors affecting the cost of the designed foundations. In research on the impact of foundation types on building costs [9], the effect of different foundation types on the construction cost of a 5-story building was examined. Excluding the foundation type, all other variables were kept constant, and the raft foundation was more economical than other foundations. Various studies have also been conducted on the effects of different earthquake zones, soil parameters, and soil classes on building costs [10-14].

When the literature above is examined, there is no study in which the effects of foundation type, number of floors and soil class on the approximate cost of the building are studied together. This study aims to fill this gap in this field. At different soil classes and different numbers of floors, i.e., total heights of the building, the foundation type to be determined at the design stage will have a significant effect on the approximate cost of the building. This effect is revealed in this study. This study selected an architectural project of a building with a uniform, symmetrical form. It addressed situations with basements and one or more floors (2-4) according to the selected floor plan. For each different number of floors, the analyses of the building were redone, followed by reinforced concrete design and analysis for various foundation types. Then, concrete, steel reinforcement, and formwork quantities were calculated separately. Subsequent analyses repeated for different soil classes and physical properties led to comparisons between the same and different foundation types under various soil classes and conditions. This research aims to evaluate the suitability of different foundation types for buildings with varying numbers of floors and soil class designs, focusing on design and cost optimization.

2. Material and method

Within the scope of this study, the floor plan of the architectural project selected is presented in Fig. 1, and the base area of the project is 341.90 m², with a floor height of 2.80 m for each floor. The ground floor reinforced concrete formwork plan is also given in Fig. 2. Considering the construction will occur in Kütahya, the material properties and the earthquake parameters determined according to the TBDY [15] were used during the reinforced concrete design and calculation stages. As material parameters, the concrete class was taken as C30, the reinforcement steel class as S 420 and earthquake parameters as Building Usage Class 3 and Earthquake Design Class 1.

Within this study's scope, the project features a symmetrical structure and is an apartment project with four units on each floor. Reinforced concrete designs and solutions for 1-4 floors, including a basement, were performed using Protastructure 2022 software (version 6.0.647). Protastructure 2022 is a domestically developed software with thousands of users worldwide, facilitating the design and analysis of steel and reinforced concrete. This software has superior features such as fast, efficient, robust analysis capabilities, integration with building information modeling, optimization tools, and collaboration ease. Thus, it allows for the more reliable and sustainable management of complex projects and assists in designing reinforced concrete structures per various regulations.

One of the most critical aspects of structural design is the foundation design. Foundations are the load-bearing elements that transfer the weight and loads of the structure to the ground. Therefore, they are essential parts of the support system that ensure the structure stands as designed. Surface foundation types such as isolated, continuous, and raft have been used in this study. Fig. 3 provides examples of 3D drawings from the design and analyses performed with the foundation types used within the scope of the study.

The primary task of foundations is to safely carry the mass of the structure, the loads arising from this mass, and the loads that may be induced by external factors, transferring them to the ground on which they sit. In particular, from a geographical standpoint, Turkey is a region that experiences many disasters, including earthquakes [16]. At this point, the characteristics of the soils on which the foundations rest are as crucial as the design of the foundations themselves. The ability of the soils to bear the loads transferred by the foundations is one of the most essential aspects in the design of foundations. According to the TBDY [15], soil classification is given in Table 1. The part with a thickness of 30 meters below the foundation subgrade level should be used for soil classification. Here, $(V_s)_{30}$ represents the average shear wave velocity for 30 meters, $(N_{60})_{30}$ represents the average standard penetration blow count for 30 meters, and $(c_u)_{30}$ represents the average undrained shear strength for 30 meters. Soils have been classified from A to F according to their strength.

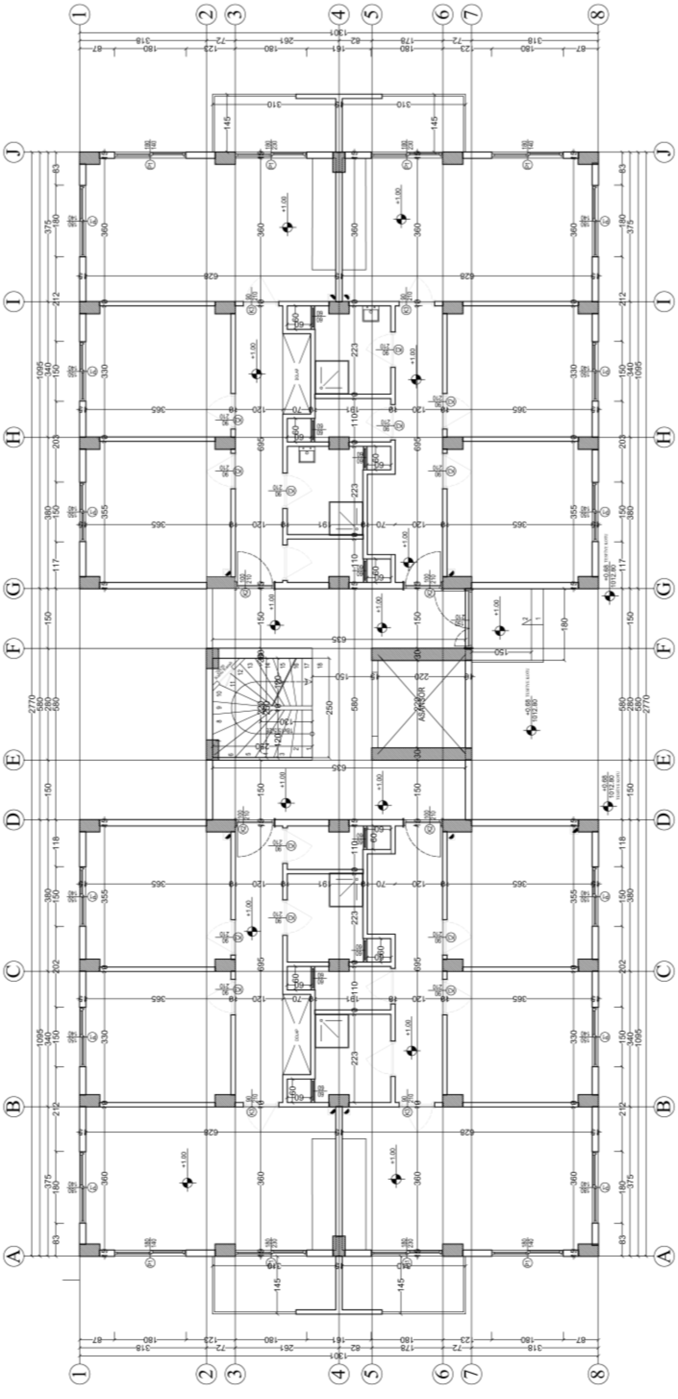

Fig. 1. Architectural floor plan.

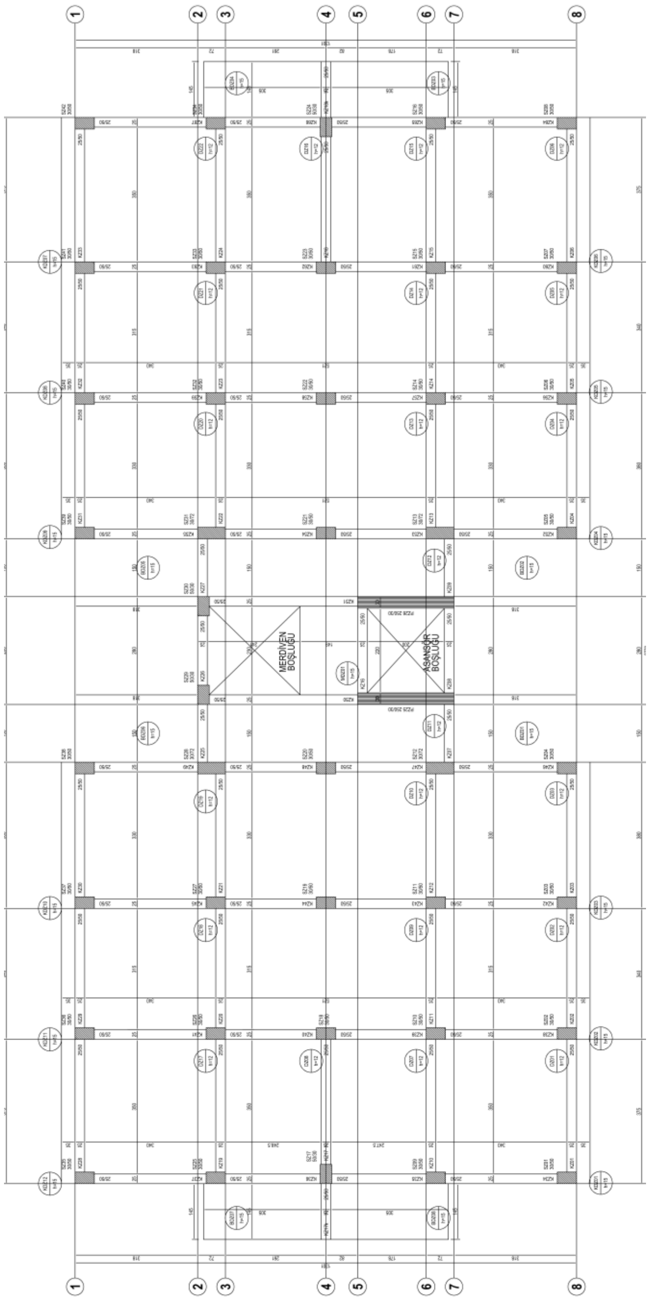

Fig. 2. Reinforced concrete formwork plan.

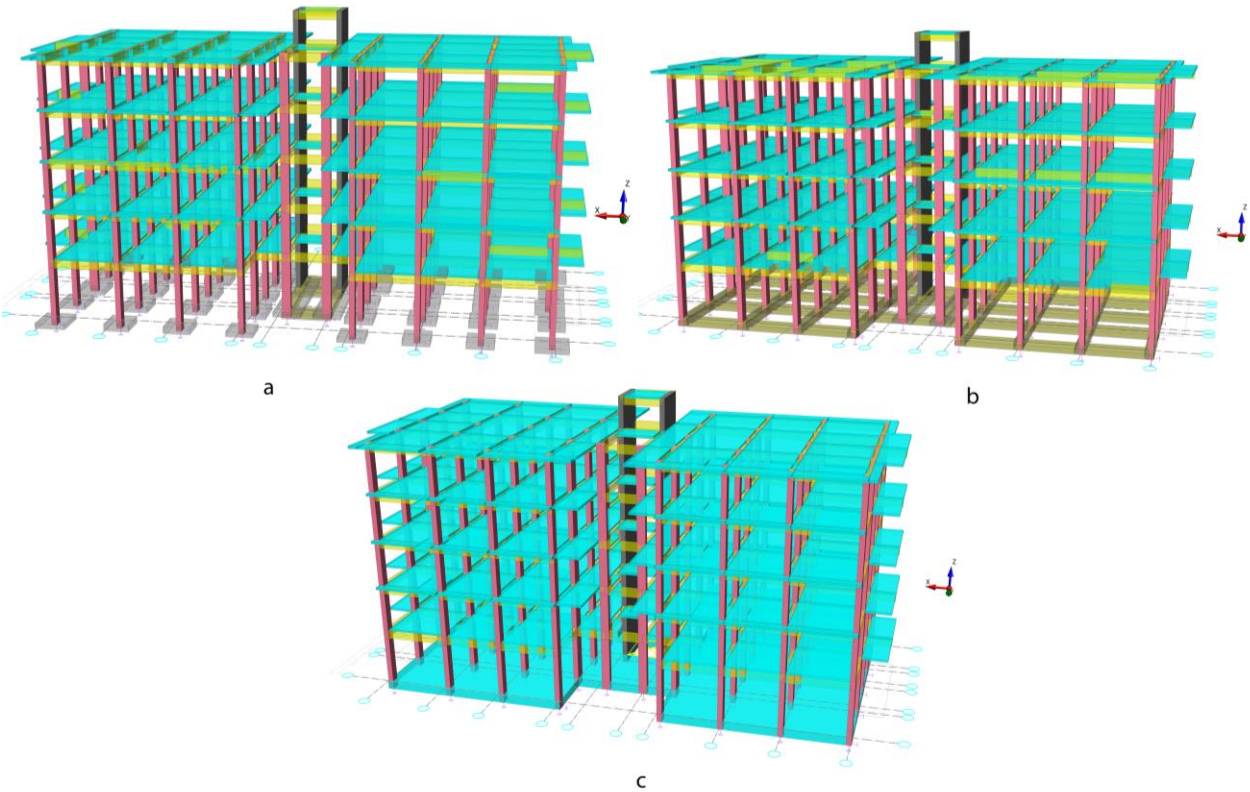

Fig. 3. Examples of reinforced concrete design; (a) Isolated foundation; (b) Continuous foundation; (c) Raft foundation.

Table 1. Local soil classes [15].

Local soil class	Floor-type	Average at upper 30 meters		
		$(V_s)_{30}$ (m/s)	$(N_{60})_{30}$ (pulse /30 cm)	$(c_u)_{30}$ (kPa)
ZA	Sturdy, hard rocks	> 1500	–	–
ZB	Slightly decomposed, moderately solid rocks	760 – 1500	–	–
ZC	Layers of very tight sand, gravel and hard clay, or weak rocks with decomposed, very cracked	360 – 760	> 50	> 250
ZD	Medium tight – layers of tight sand, gravel or very solid clay	180 – 360	15 – 50	70 – 250
ZE	Profiles containing layers of loose sand, gravel or soft–solid clay or a layer of soft clay thicker than 3 meters in total (c_u < 25 kPa) satisfying conditions of PI > 20 and w > 40%	< 180	< 15	< 70
ZF	Soils requiring site-specific research and evaluation			

In the context of the study, initially, the design and analyses for the said project were carried out on a rock soil with soil class ZB, and the design strengths and coefficient of soil reactions were selected according to this soil. Subsequent analyses were performed for soil classes such as ZC, ZD, and ZE. The necessary parameters for the soil classes used in these analyses were obtained from previous soil survey reports in Kütahya. In this context, the design strengths and coefficient of soil reactions received from the reports were calculated separately for different foundation types as specified in TBDY [15]. As known, TBDY [15] explains how to calculate the design strength, and here, the differences that may arise in terms of foundation types begin primarily with foundation geometry and dimensions. Different design strength values and coefficient of soil reactions emerge when considering different geometries or sizes for various foundation types to be constructed on the same soil.

It should also be noted that the calculations during structural design and analysis consider continuous boundary values. In other words, while performing calculations with different foundation types for each building solution, the minimum values have been selected by TBDY [15], the Provision for the Design and Construction of Reinforced Concrete Structures (TS 500) [17], and minimum values have been used until a safe solution is obtained.

According to TS 500 [17], when designing isolated foundations, the smallest dimension in the plan cannot be less than 70 cm, and the foundation area cannot be less than 1 m². The foundation depth cannot be less than 25 cm and cannot be smaller than 1/4 of the cantilever span. Similarly, for continuous foundations, according to TS 500 [17], if the foundation is beam-designed, the thickness of the foundation beam cannot be less than 1/10 of the free span, and the plate thickness cannot be less than 20 cm; if it is designed without beams, then the plate thickness cannot be less than 30 cm. Thus, the minimum design dimensions were selected in this way. The thickness of the raft foundation also started from a minimum of 30 cm. After the analysis and calculations, if the dimensions were insufficient, they were increased and analyzed again. Increases were made using as small numbers as possible. For example, raft thicknesses were increased by 1-2 cm increments, and the analyses were repeated. It should be noted here that in market conditions, raft thicknesses are generally increased in 5-10 cm increments rather than making such increments. After completing the design, analysis, and calculations, the concrete, formwork, and steel reinforcement quantities for all the designed reinforced concrete structures were extracted. Then, these quantities were multiplied by the TCÇŞİDB 2024 to obtain approximate costs. Subsequently, the necessary comparisons were made with these costs.

3. Material and method

This section presents the results and findings of analyses conducted on the selection of foundation type - one of the factors influencing the approximate rough construction cost of buildings with a reinforced concrete support system -. In the study, isolated, continuous, and raft foundation types have been comparatively considered for buildings with different numbers of floors (1-4 floors above the basement) and various soil classes (ZB-ZE). The soil parameters used in the analyses are given separately for the local soil classes applied in Table 2. The variations in values calculated according to TBDY [15] are due to the inclusion of foundation geometry and foundation dimensions in the calculation of design strength.

Table 2. Utilized soil parameters.

Local soil classes	Unit weight (t/m^3)	Isolated foundation		Continuous foundation		Raft foundation	
		Design strength (t/m^2)	Coefficient of soil reaction (t/m^3)	Design strength (t/m^2)	Coefficient of soil reaction (t/m^3)	Design strength (t/m^2)	Coefficient of soil reaction (t/m^3)
ZB	2.49	41.80	2341	39.00	2184	40.40	2262
ZC	2.24	34.50	1932	29.50	1652	31.50	1764

ZD	1.87	25.50	1428	20.50	1148	22.50	1260
ZE	1.92	21.00	1176	18.40	1030	19.20	1075

As a result of the analyses, the quantities of concrete, formwork, and reinforcement steel, along with their total approximate costs obtained by multiplying these quantities by TCÇŞİDB 2024, are given separately for each soil class in Tables 3-6. The graphical representation of the data in the tables is provided in Figs. 4-7.

Table 3. ZB local soil class for floor level specific concrete, formwork, and reinforcement steel quantities and total cost.

Number of floors (excluding basement)	Foundation type	Concrete volume (m^3)	Formwork area (m^2)	Construction steel (Ø 8-12 mm) (tn)	Construction steel (Ø 14-28 mm) (tn)	Approximate total cost (TL)
	Isolated	251.127	1,731.11	16.185	8.395	2,590,006.15
1	Continuous	223.763	1,905.27	14.812	9.717	2,623,786.94
	Raft	282.040	1,609.50	21.827	5.074	2,677,158.01
	Isolated	326.306	2,455.07	22.999	10.161	3,537,558.44
2	Continuous	311.011	2,632.75	21.236	12.776	3,635,064.46
	Raft	367.555	2,336.56	28.801	7.125	3,669,149.16
	Isolated	410.281	3,187.14	30.045	12.044	4,525,526.48
3	Continuous	406.363	3,355.31	28.722	16.160	4,711,182.77
	Raft	469.393	3,068.71	36.395	9.304	4,733,290.62
	Isolated	497.994	3,923.15	36.849	13.466	5,502,992.40
4	Continuous	498.127	4,083.51	35.447	19.574	5,756,720.65
	Raft	571.231	3,800.85	44.416	11.282	5,805,199.42

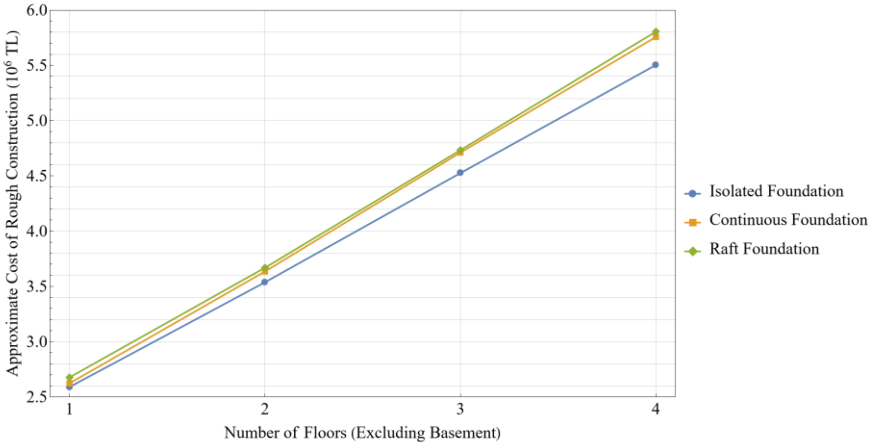

Fig. 4. Changes in approximate cost depending on foundation type and number of floors in local soil class ZB.

According to Table 3, as expected, buildings on ZB class soil with higher foundation strength and coefficient of soil reaction isolated foundations have a lower cost than others. The difference between the costs widens as the floor count increases. In the case of a building on a single basement floor, isolated foundations are approximately 1.2875% less expensive than continuous foundations and about 3.2554% less than raft foundations. However, this difference grows as the number of floors increases, with the cost of isolated foundations being approximately 4.4075% lower than continuous and about 5.2058% lower than raft foundations for a four-story building above the basement.

Table 4. ZC local soil class for floor level specific concrete, formwork, and reinforcement steel quantities and total cost.

Number of floors (excluding basement)	Foundation type	Concrete volume (m^3)	Formwork area (m^2)	Construction steel (Ø 8-12 mm) (tn)	Construction steel (Ø 14-28 mm) (tn)	Approximate total cost (TL)
	Isolated	325.623	1,811.41	17.167	10.372	2,938,759.89
1	Continuous	224.214	1,905.41	14.851	9.685	2,625,346.97
	Raft	282.084	1,609.50	21.446	6.532	2,711,901.70
	Isolated	446.768	2,593.89	24.527	14.313	4,136,227.65
2	Continuous	313.836	2,633.31	21.731	13.103	3,670,237.23
	Raft	377.375	2,339.61	29.091	8.942	3,766,334.69
	Isolated	508.595	3,292.90	31.258	16.226	5,034,023.93
3	Continuous	411.536	3,356.23	29.345	16.992	4,773,645.65
	Raft	472.666	3,069.72	36.658	11.033	4,807,776.33
	Isolated	567.790	4,002.47	37.933	18.113	5,928,696.31
4	Continuous	507.343	4,085.20	35.856	20.681	5,832,319.26
	Raft	577.778	3,802.89	44.150	13.746	5,895,298.50

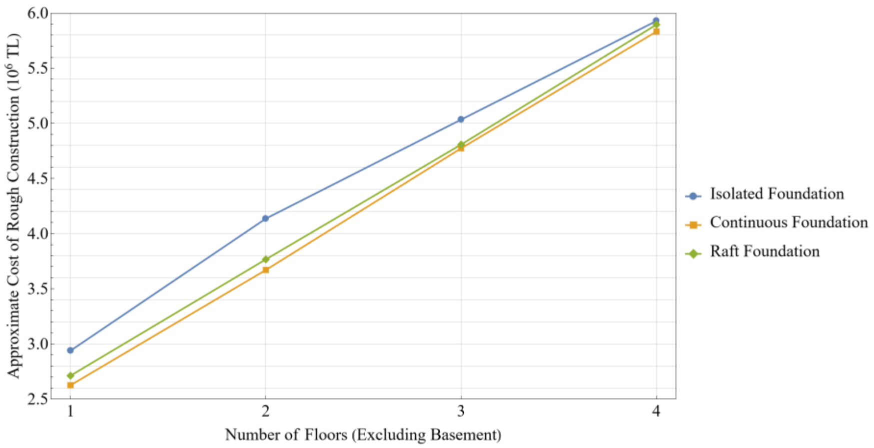

Fig. 5. Changes in approximate cost depending on foundation type and number of floors in local soil class ZC.

In Table 4, the quantities of concrete, formwork, and reinforcement steel, along with their approximate costs, are shown for a building designed on ZC-class soil with different numbers of floors and foundation types. As shown in

Fig. 4, on ZB-type soil, as the number of floors increases, using isolated foundations significantly reduces the approximate rough construction cost to the extent reinforced concrete design allows. However, as the soil parameters decrease, the soil becomes less resistant, and the cost of isolated foundations increases considerably, as seen in Table 4 and Fig. 5.

For ZC class soils, it is understood from Table 4 and Fig. 5 that continuous foundations are the most cost-effective option. Looking at the cost between raft and continuous foundations, the cost difference decreases significantly as the number of floors increases. For example, while the difference in approximate cost for a building designed on a single basement floor is about 3.3%, this difference falls below 0.75% for three floors above the basement. It should not be forgotten that the calculated approximate costs only pertain to concrete, formwork, and reinforcement steel; when considering the total cost of the building, this percentage difference will be even lower.

Table 5. ZD local soil class for floor level specific concrete, formwork, and reinforcement steel quantities and total cost.

Number of floors (excluding basement)	Foundation type	Concrete volume (m^3)	Formwork area (m^2)	Construction steel (Ø 8-12 mm) (tn)	Construction steel (Ø 14-28 mm) (tn)	Approximate total cost (TL)
	Isolated	358.480	1,841.35	17.610	11.509	3,098,022.36
1	Continuous	228.568	1,906.45	15.276	9.764	2,654,522.63
	Raft	282.084	1,609.50	21.823	6.702	2,730,059.61
	Isolated	505.339	2,644.28	25.005	16.503	4,413,158.66
2	Continuous	331.419	2,636.75	22.122	13.230	3,737,023.41
	Raft	383.921	2,341.65	29.441	8.948	3,797,184.58
	Isolated	638.888	3,371.24	32.317	21.045	5,626,729.08
3	Continuous	436.353	3,361.03	29.558	16.831	4,845,415.03
	Raft	489.033	3,074.81	37.150	11.693	4,893,025.96
	Isolated	708.586	4,076.48	39.000	23.178	6,555,220.77
4	Continuous	538.741	4,091.18	36.182	20.799	5,935,387.40
	Raft	590.739	3,806.96	42.465	16.882	5,978,296.87

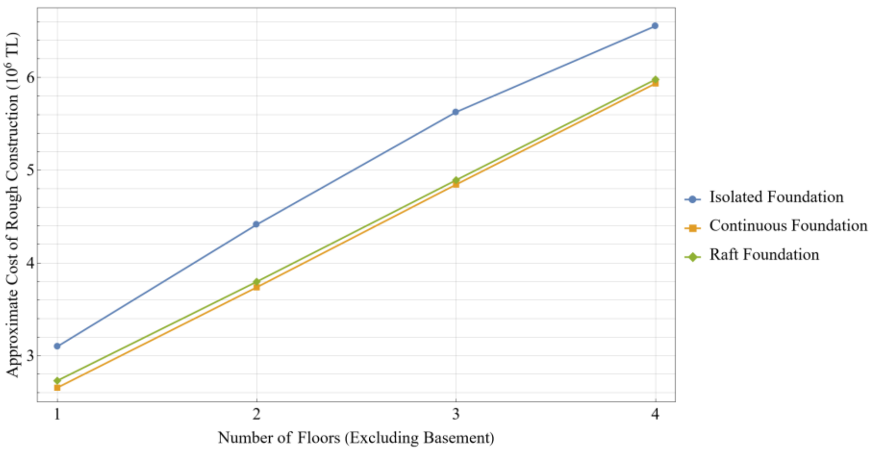

Fig. 6. Changes in approximate cost depending on foundation type and number of floors in local soil class ZD.

The quantity results and approximate costs for a building designed on ZD-class soil are presented in Table 5, with the graphical representation provided in Fig. 6. It is noteworthy that as the soil's design strength and soil reaction coefficient values decrease. The soil class worsens, and the cost difference between continuous and raft foundations decreases even when the number of floors is low. Continuous foundations emerge as the most cost-effective foundation type for ZD class soil, where the approximate cost of isolated foundations is again very high due to soil conditions. However, while the price of raft foundations is about 2.85% higher than continuous foundations for a single floor above the basement, this excess cost drops to around 0.73% for four floors above the basement.

Finally, Table 6 presents the results for a building designed and analyzed for construction on ZE class soil, which has the lowest soil parameters in the study. The graph created based on these results is provided in Fig. 7. The outcomes observed for ZD class soil are similarly applicable for ZE class soil. Again, continuous foundations stand out as the most cost-effective, while the cost difference compared to raft foundations continues to decrease. As previously mentioned, as the soil class weakens in strength, the heightened cost of isolated foundations, which are not very sensible in design and production under such conditions, also becomes noteworthy.

Table 6. ZE local soil class for floor level specific concrete, formwork, and reinforcement steel quantities and total cost.

Number of floors (excluding basement)	Foundation type	Concrete volume (m^3)	Formwork area (m^2)	Construction steel (Ø 8-12 mm) (tn)	Construction steel (Ø 14-28 mm) (tn)	Approximate total cost (TL)
	Isolated	407.960	1,884.06	18.025	13.252	3,328,965.83
1	Continuous	234.929	1,907.71	15.492	9.905	2,684,281.03
	Raft	282.084	1,609.50	21.843	6.782	2,733,347.26
	Isolated	592.598	2,714.75	25.718	19.794	4,823,733.04
2	Continuous	342.506	2,638.89	22.173	13.281	3,771,594.03
	Raft	393.741	2,344.70	30.062	8.953	3,846,526.37
	Isolated	747.122	3,482.55	32.978	27.611	6,224,470.09
3	Continuous	453.932	3,364.46	29.774	16.931	4,905,408.50
	Raft	501.983	3,078.88	35.417	14.974	4,979,077.18
	Isolated	873.159	4,209.07	40.063	29.613	7,327,373.02
4	Continuous	560.361	4,095.18	36.387	20.602	5,996,627.98
	Raft	603.963	3,811.03	43.156	16.938	6,041,456.33

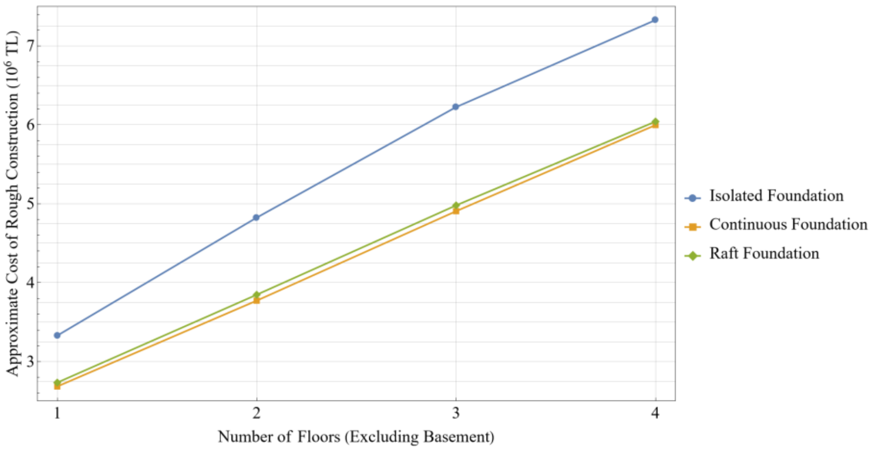

Fig. 7. Changes in approximate cost depending on foundation type and number of floors in local soil class ZE.

Another point regarding Tables 4-6 that should be addressed pertains to isolated foundations. Suppose the quantities and approximate costs associated with isolated foundations are examined. In that case, it is noticeable that as the number of floors increases, the difference from other types of foundations relatively decreases. Upon investigation, this phenomenon is attributed to eccentricity in the design of isolated foundations. Due to the geometric design requirements of isolated foundations, especially under seismic loadings, the forces generated often result in isolated foundations for lower numbers of floors being as large or even more significant than those for buildings with higher floors.

Figures 8-11 graphically present the cost variations for different floor counts according to various local soil classes.

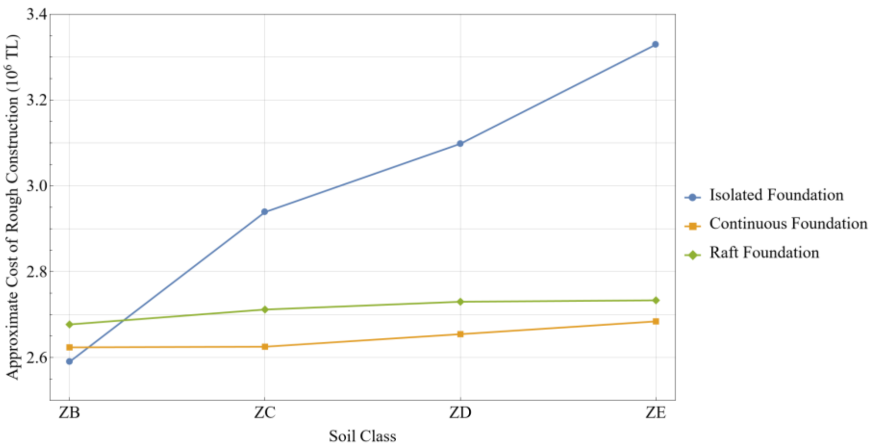

Fig. 8. Cost changes depending on foundation type and soil class for a single floor above the basement.

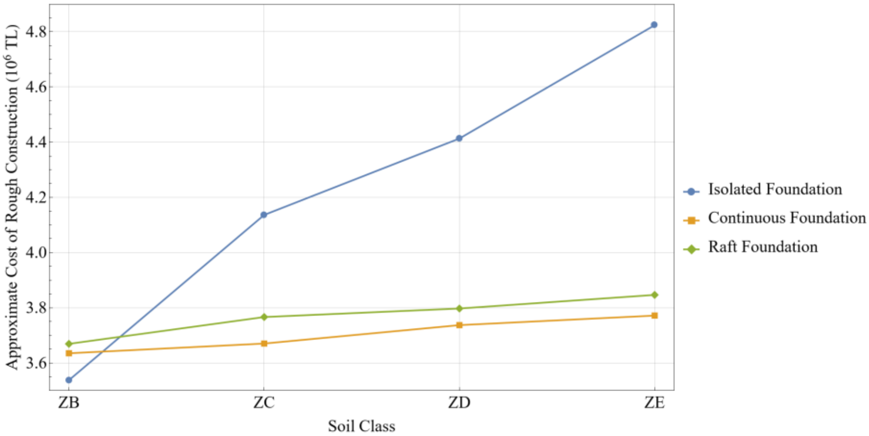

Fig. 9. Cost changes depending on foundation type and soil class for 2 floors above the basement.

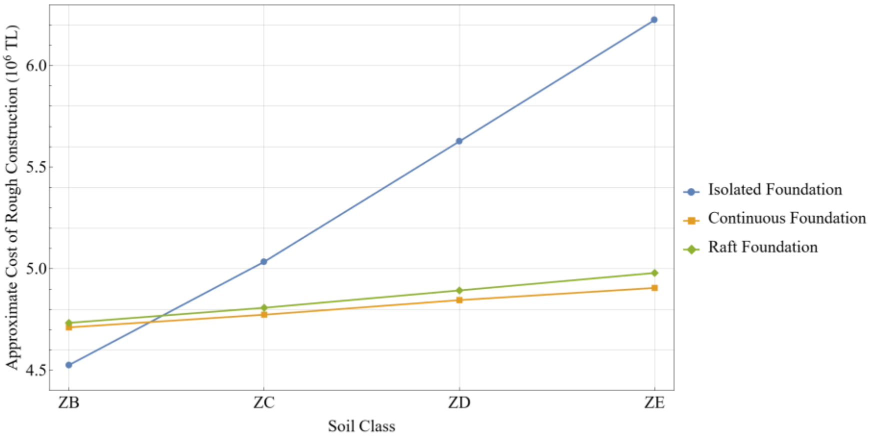

Fig. 10. Cost changes depending on foundation type and soil class for 3 floors above the basement.

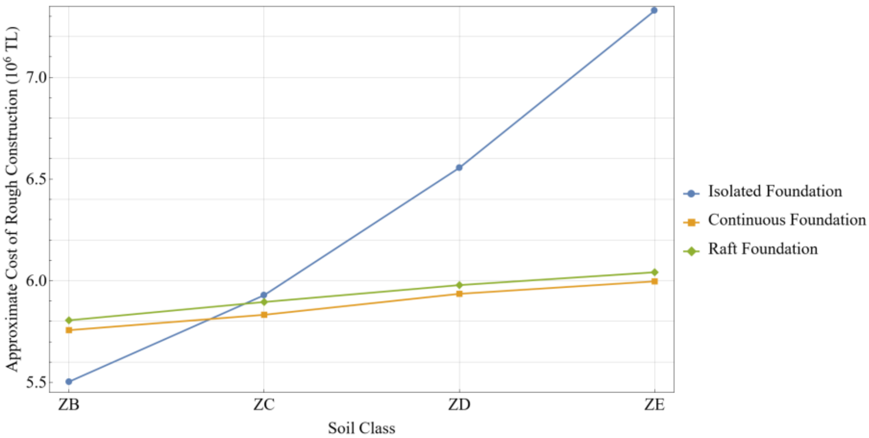

Fig. 11. Cost changes depending on foundation type and soil class for 4 floors above the basement.

One of the most significant findings emerging from the design and analyses conducted within the scope of the study is that for structures to be constructed on soils with higher bearing capacity, such as ZA and ZB classes, designs utilizing isolated foundations tend to be more cost-effective. This is mainly due to the influence of dimension restrictions during the design phase as per the regulations in Turkey. Continuous foundations emerge as the most cost-effective foundation for soils with lower bearing capacities. Moreover, raft foundations also appear as the main competitors to continuous foundations regarding the cost of these types of soils.

4. Conclusions

This study has investigated the impact of different shallow foundation types on the approximate rough construction cost of buildings with reinforced concrete support systems. Isolated, continuous, and raft foundations were comparatively analyzed for buildings with varying floors and soil classes. Isolated foundations emerge as the most cost-effective foundation type regardless of the number of stories on soils with higher bearing capacities. A significant reason for this is the minimum size rules applied to continuous and raft foundations as per TS 500 [17]. As soil-bearing capacity decreases, continuous foundations become more cost-effective.

The analyses have shown that raft foundations are more expensive than continuous foundations. However, it is crucial to note that this cost difference only encompasses concrete, formwork, and steel reinforcement quantities. When comparing the costs of these quantities, particularly as the number of stories increases, the cost difference significantly decreases. Considering the local soil classes of ZC, ZD, and ZE, the cost difference for a single-floor building above the basement is approximately 2.657% on average, 2.072% for two floors, 1.067% for three floors, and 0.850% for four floors. As the number of stories increases, the cost difference between continuous and raft foundations significantly diminishes. Moreover, it is evident that when considering the overall building (both fine and rough construction) costs, the percentage cost difference between the raft and continuous foundations will further decrease.

Another point that stands out when examining Tables 3-6 is the formwork quantities. As expected, the formwork quantities are lower for raft foundations than other types. One of the first and most significant effects of this situation is the reduced cost of formwork scaffolding, which directly influences the overall approximate cost of the building. The indirect effect is that formwork labor for raft foundations will be less, resulting in time savings and, consequently, shorter project delivery times.

The filling process is another significant cost difference between isolated and continuous foundations compared to raft foundations. The filling required for isolated or continuous foundations brings substantial costs and risks. Initially, there will be the cost of filling material and the cost of spreading and compacting this material. Then, the cost of wire mesh reinforcement and slab concrete will also be added. Alongside all these costs, there are risks, such as damage to column stubs during compaction of the fill and the potential for settlement of the fill material. Furthermore, the necessity of filling, like formwork labor, will also extend the project delivery times to a certain degree.

When all these risks and costs are considered, it can be said that, especially for soil class ZC and local soils with lower strength, there is no significant difference between continuous and raft foundation construction costs. Particularly in Turkey, which harbors substantial seismic risks, even if it were possible, deciding on the type of foundation solely based on the cost parameter, without considering other factors, does not entirely reflect reality; the idea that raft foundations are much more costly than other shallow foundations is not wholly accurate.

In conclusion, many factors must be carefully considered when selecting the most suitable foundation type for each project. This study aims to provide a broader perspective by including the impact of the cost factor in choosing the foundation type. It underscores the importance of assessing each project's unique needs and conditions.

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