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Research Article

L-shaped reinforced concrete retaining wall design: cost and sizing optimization

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ABSTRACT

In the context of this study, the design of L-shaped reinforced concrete retaining walls have been scrutinized parametrically depending on the simultaneous analysis of cost and sizing with the use of a recent optimization algorithm. The differences and restrictions of L-shaped reinforced concrete retaining wall design than classical T-shaped walls have been also discussed. The foundation width and the thickness of the wall required for a safe design has been also investigated according to the change of excavation depth, the type of soil dominating field and the external loading conditions. The observed results from optimization analyses shows that the variation of the shear strength angle is the most significant soil geotechnical parameter for supplying an envisaged safe design against sliding, overturning and adequate bearing capacity. Concurrently, the excavation depth is the most important factor that is forming the necessity of the construction of the retaining structure and optimal dimension evaluation. It is also proved that the wall foundation width is the most effected dimension of the retaining structures by the change of design parameters and the cost difference is directly influenced by the change of sizing. A cost-effective wall design can be performed with the use of proposed optimization analysis is capable in a shorter time than the traditional methods. Eventually, it has shown that such optimization methods may be useful to find the optimal design requirements for geotechnical engineering structures.

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1. Introduction

Retaining walls are basic type of civil engineering structures that are widely used to support excavation works or equipoise the lateral pressures when there is a difference in elevation. The main aim to construct a wall system is to resist lateral earth pressures with the self-weight of the whole system (Coulomb, 1776; Rankine, 1857; Boussinesq, 1882; Terzaghi, 1941). Depending on the project requirements, land ownership, environmental limitations and infrastructure locations it can be essential to build the sections of the wall with restrictions. L-shaped reinforced concrete retaining walls are the most common types of these restricted supporting systems. In such a case, the toe of the wall system is not constructed and the stability of the wall is controlled according to this limited section. The term "stability" means to ensure not also geotechnical but also structural design requirements simultaneously. Geotechnical stability conditions necessitates to supply sliding, overturning and total failure safety. In addition to this, the sections of the wall have to procure adequate shear and moment capacities and the steel reinforcement has to satisfy the relevant code requirements for reaching structural safety (Sasidhar et al., 2017). For a restricted type of retaining wall, it can be a significant problem to obtain stability conditions because the lack of one of the structural elements of the wall system causes to reduce resisting forces of the wall. This condition contributes to enlarge the foundation heel of the wall unpredictably.

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When this is the case, the construction works will not be economic. That's why, to acquire optimum cost of the wall connected to safe design have to be the most important factor for both engineers and employers. Several different methods are preferred to procure cost and sizing equilibrium depending on the advancements in computer technologies. Particle swarm optimization (Kennedy and Eberhart, 1995; Nedushan and Varaee, 2009), Genetic algorithm (Kalateh-Ahani and Sarani, 2019; Sasidhar et al., 2017; Holland, 1975; Kaveh et al., 2013), Big bang big crunch (Dorigo et al., 1996; Camp and Akin, 2012), Harmony search algorithm (Geem et al., 2001; Kaveh and Abadi, 2011; Uray et al., 2019), Bat algorithm (Yang, 2010), simulated annealing (Ceranic et al., 2001; Yepes et al., 2008; Pei and Xia, 2012), Grey wolf optimization (Bekdaş and Temur, 2018), teaching learning based optimization (Bekdaş and Niğdeli, 2016; Bekdaş and Temür, 2017) techniques can be given as examples of applied new methods to the optimization problem of retaining walls.

In the present study, L shaped retaining wall systems are parametrically designed taking into consideration the optimization of cost and sizing simultaneously. The focus point of the study is to obtain optimum design of restricted walls with the change of effective parameters on the envisaged design process. The effects of the change of soil properties, loading conditions and excavation depth is taken into consideration through the analyzed 105000 different cases that are performed with a recently proposed algorithm called Jaya. The results of the optimization analyses have been shown with two steps. The first step is based on the evaluation of the change of design parameters on the costs and the second step is the achievement of design due to the variation of envisaged parameters.

2. Methodology

In the Fig. 1, the cross section of a standard L-shaped retaining wall and the mobilized loads that are effecting on the wall system is illustrated. In Fig. 1, the height of the wall stem (H), the excavation depth (h), the embedment depth (d), the thickness of foundation base (x_5), the foundation heel width (x_1), the width of the stem at the base level (x_4) and the width of the stem at the ground level (x_3) is shown. Rankine Earth Pressure Theory is used to calculate active and passive earth pressure coefficients K_a ($\tan^2[45\text{-}\Phi/2]$) and K_p ($\tan^2[45+\Phi/2]$). W_{ws} and W_{wf} is the weight of the wall stem and the foundation base respectively. W_{sa} is the weight of the backfill soil retained on the foundation heel. $q_{\max}$ and $q_{\min}$ is the base pressures acting through the foundation. P_t is the average value of base pressures acting from the center of the gravity of foundation. P_{sa}, P_{sp} is the lateral soil forces for active and passive state and they can be calculated by the use of Eqs. (1) and (2) for pure frictional soils. It is a well-known issue that the passive lateral stresses are induced in relation to the embedment depth of the retaining structures. The activation of passive lateral earth forces causes to increase the resistance of the soil mass not to fail. But within the concern of this study, it is preferred not to use the passive earth pressures in stability analysis to stay on the safer side.

$$P_a = 0.5\gamma_s H^2 \tan^2([45 - \Phi/2]) \quad (1)$$

$$P_p = 0.5\gamma_s H^2 \tan^2([45 + \Phi/2]) \quad (2)$$

The term γ_s represents the unit weight of soil. An infinite distributed external load q_a is acted at the ground level and it is converted to horizontal load, Pq_a by the multiplication of active lateral earth coefficient of backfill material. The integrated components of the lateral disturbing forces can lead wall to slide through the base of the wall foundation. The wall system has to acquire enough security to carry this kind of unbalanced lateral loads. Dividing the sum of lateral resistant forces to the sliding forces gives the degree of sliding safety (SFs). The heaviness of the wall, the foundation soil base friction and the passive forces (it is not taken into consideration for current study) generates the resistant forces. Beside these states, the lateral component of the soil active forces and the surcharge loads induce unbalanced forces. The activation of lateral forces both active and passive leads the wall to overturn about its toe point (point A in Fig. 1). Dividing the sum of the moments generated by the resistant forces to the moments that is trying to slide the system, gives the safety degree for overturning behavior (SFo). In addition to these safety investigations, the bearing capacity failure has to be controlled by the division of ultimate bearing pressure to the maximum mobilized soil base pressure through the base of the wall. The upper and lower bounds of the soil base pressure values can be determined by the use of traditional bearing capacity equations proposed for shallow foundations (Dembicki and Chi, 1989; Powrie, 1996; Bowles, 1988; Yıldırım, 2002). In this study, the mentioned safety control of the wall section is tried to be controlled by the use of Jaya Algorithm that is proposed by Rao (2016) through the analysis conducted by Matlab Software. The logic of the Jaya Algorithm depends on the searching of the problem that has to be towards the best solution and has to stand aloof the worst solution which is used to choose the optimum sizing of the envisaged structure and to find minimum cost. The advantage of using Jaya Algorithm can be defined that it requires to identify the general control parameters as the number of generations and population size. Besides, no algorithm-specific parameters, that are special parameters to control for different algorithms. Hence, it is only required to elementally select the common control parameters in the Jaya algorithm without having to define more complex control parameters in applications. By the way Jaya Algorithm can be applied to several real-world optimization problems. That is the reason why to select the Jaya Algorithm to check the cost-effective design of L shaped reinforced concrete retaining walls in this paper. In the context of this study, in order to perform analysis with Jaya Algorithm for the evaluation of optimum sizing and cost relationship a certain flow has to be followed. Firstly the constant parameters of the retaining wall system, algorithm parameters, and the ranges of the design parameters have to be defined and then the initial solutions are generated randomly. Until the attainment of stopping criteria, existing solutions are modified by the use of features of Jaya Algorithm. In consequence of the obtainment of the stopping criteria the analyses are stopped. Six different design variables (X_1, X_3, X_4, X_5, X_6, X_7) are considered in order to perform the optimization analysis of L-shaped reinforced concrete retaining walls that are given in Table 1. The variables are divided into two sections according to the related parameters with cross-section and reinforced concrete design. The first variable set includes the length of the heel and the thickness of the stem at the top, at the bottom and foundation base respectively. The second set includes the area of reinforcing bars of the stem and foundation heel. The design process begins with the scanning of safety values against the envisaged failure modes then if the satisfaction is gained it becomes necessary to define the implementation of the requirements of reinforced concrete. ACI 318-05 code is preferred to use because of its prevalent usage. This code proposes to define equivalent rectangular compressive stress distribution. As regards to the equivalent compressive stress distribution, the moment capacity of the wall system can be determined and only the critical sections of the stem and foundation is checked for the design of the reinforcement. The design constraints on strength and dimensions are shown in Table 2.

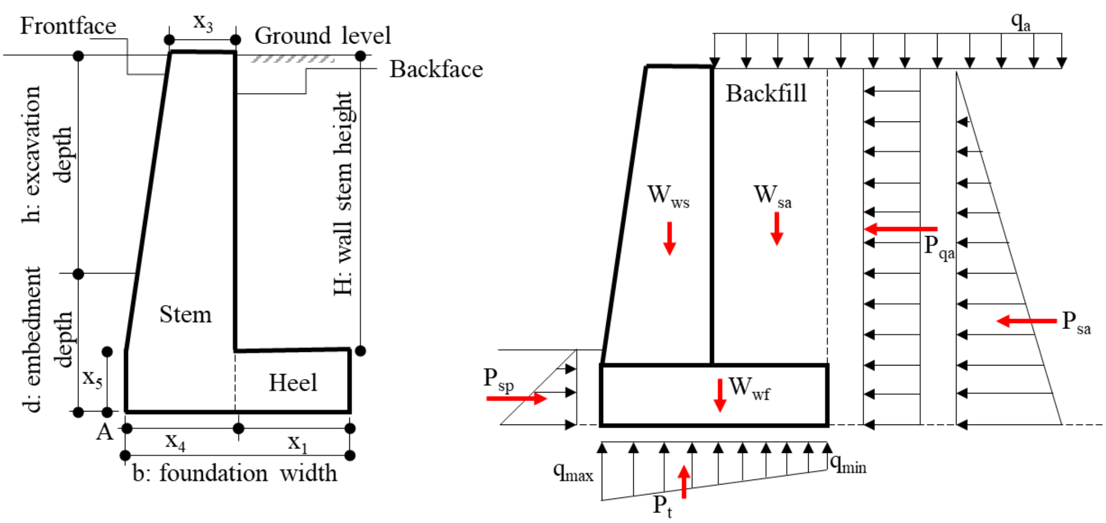

Fig. 1. L-shaped retaining wall cross section and the load distribution mode of administration.

Table 1. Definitions of L-shaped wall design variables.

	Symbol	Description of parameter
Variables in relation to cross-section dimension	X_1	Length of the heel (x_1)
	X_3	Thickness of wall stem at the top (x_3)
	X_4	Thickness of wall stem at the bottom (x_4)
	X_5	Thickness of wall foundation (x_5)
Variables in relation to reinforced concrete design	X_6	Area of reinforcing bars of the stem
	X_7	Area of reinforcing bars of foundation heel

Table 2. Design constraints on strength and dimensions.

Description	Constraints
Safety for overturning stability	$g_1(X)$: $F_oS_{ot,\text{design}} \geq F_oS_{ot}$
Safety for sliding	$g_2(X)$: $F_oS_{s,\text{design}} \geq F_oS_s$
Safety for bearing capacity	$g_3(X)$: $F_oS_{bc,\text{design}} \geq F_oS_{bc}$
Minimum bearing stress (q_{min})	$g_4(X)$: $q_{\min} \geq 0$
Flexural strength capacities of critical sections (M_d)	$g_{5\text{-}7}(X)$: $M_d \geq M_u$
Shear strength capacities of critical sections (V_d)	$g_{8\text{-}10}(X)$: $V_d \geq V_u$
Minimum reinforcement areas of critical sections (A_{smin})	$g_{11\text{-}13}(X)$: $A_s \geq A_{s\min}$
Maximum reinforcement areas of critical sections (A_{smax})	$g_{14\text{-}16}(X)$: $A_s \leq A_{s\max}$

The objective function of the performed analysis is preferred to include only the material costs to compare the effects of variants of the design process. Material costs that consist of the sum of concrete and reinforcing steel bars are defined by using the costs per unit volume/weight. The mathematical expression of the recommended objective function can be calculated by Eq. (3).

$$\min f_x = C_{concrete}.V_{concrete} + C_{steel}.W_{steel} \tag{3}$$

In this equation, C_{concrete} is the unit cost of concrete and C_{steel} is the unit cost of steel material, V_{concrete} is the volume of used concrete and W_{steel} is the weight of used steel per unit length.

3. Numerical Examples

The proposed methodology is applied to randomly select numerical examples that have been conducted in order to evaluate the effects of soil properties, surcharge loading conditions and excavation depth on the cost and sizing of L-shaped restricted retaining walls. The surrounding soil, backfill soil and foundation soil are assumed to be the same and they consist of pure frictional soils. The shear strength angle, unit weight of soil and ultimate soil pressure is taken into consideration as the variants of soil properties. The shear strength angle has been chosen from a range that is representing the strength characteristics of frictional soils loose to very dense in reference to Bowles (1988) (28° to 38°). The unit weight has been selected between 16 to 20 kN/m^3 to represent sandy soils and the ultimate soil pressure has been chosen 250, 300, 350, 400 kPa respectively for the analyzed cases. Excavation depth has been selected 4, 6, 8, 10, 12 meters and the surcharge load have been assumed to act from the ground surface locating at the backfill side. The excavation depths have been selected within the scope of the existing limits of the national and international related literature. The absence of the surcharge load and the effects of 5, 10, 15 and 20 kPa loading condition is investigated respectively. In the solution of the selected optimization cases, some constraints related to the dimensions of the wall system are applied. The lower and upper boundaries of top and bottom thickness of the wall stem is assumed to be between 0.2-3 meters and the thickness of the foundation is taken between 0.2-10 meters for all optimization analyses (Bowles, 1988). Other restrictions about the material properties, the safety degrees and the costs are listed in Table 3.

Table 1. The design constants and design variables of retaining walls.

Symbol	Definition	Value	Unit
μ	Concrete-soil friction	tan (2/3) ϕ	-
f_y	Yield strength of steel	420	MPa
f'_c	Compressive strength of concrete	25	MPa
c_c	Concrete cover	30	mm
E_{steel}	Elasticity modulus of steel	200	GPa
γ_{steel}	Unit weight of steel	7.85	t/m^3
γ_{concrete}	Unit weight of concrete	25	kN/m^3
C_c	Cost of concrete per m^3	75	$
C_s	Cost of steel per ton	700	$
SF_o	Factor of safety for overturning	1.5	-
SF_s	Factor of safety for sliding	1.5	-
SF_{bc}	Factor of safety for bearing capacity	3.0	-

4. Discussion and Results

It is a well-known issue that in the design process of a retaining wall system, the excavation depth, the geotechnical properties of soil and the loading conditions are crucial parameters that are affecting the design of retaining structures. In this respect, in this section it is aimed to control the effects of the mentioned parameters to the optimal cost effective design of L-shaped reinforced retaining walls. A great number of parametric analysis of envisaged different cases due to the changes in identifying parameters has been performed taking into consideration the constraints of the design. Totally 105000 optimization analysis is obtained and graphs are illustrated for selected special cases in order to describe the change of cost and sizing due to the related parameters. At the first step of the discussions, the change in total material cost is investigated and a number of specific reference cases are described to compare the influence rates of variants. At the second step, the change of wall sizing subjected to the variants is discussed with the calculation of foundation base thickness and total width.

Step 1: Total material cost change of construction:

In Fig. 2, the change in the total material cost of envisaged retaining wall design is taken into consideration against the increase of excavation depth with the change of the shear strength angle of the soil medium. The ultimate soil base pressure is assumed to be constant (q_s= 250 kPa) and the external load is not existing. The unit weight of the soil has assumed to be the third variable for the analysis and Fig. 2 is drawn for both 16 and 19 kN/m³ values of unit weight. The lateral axes is fixed to reach the same numeric value to ease the comparison. It is very explicit to say that the increase of the excavation depth rises the costs as the same manner for all the fictionalized cases. The change of soil unit weight hasn't got a significant effect for the discussions made with the evaluation of same excavation depth. In order to compare the influence rate of soil strength properties a reference constant excavation depth value can be selected and it can be seen that the strength of granular soil with the increase of shear strength angle leads costs to decrease. In conjunction with this, the influence ratio of shear strength angle increases with the increment of excavation depths. In all the cases except the case that the soil unit weight is 16 kN/m³ and the shear strength angle is 38°, there cannot be able to obtain a proper design that is supporting 12 meters excavation depth due to the lack of technical adequateness (either geotechnical or static design safety requirements) within the limits of defined design variables. This situation can be categorized for procuring design restraints of L-shaped reinforced concrete retaining walls and maybe a limitation with a function of excavation depth can be asserted for defining the constructability of L-shaped walls. In Fig. 3, the change of total cost against the change of external loading conditions are given for two different excavation depth assumptions. The first case is defined for 4 meters and the second case is defined for 8 meters excavation depths. The ultimate base bearing capacity and the cost of concrete is assumed to be constant and selected to be 250 kPa and 75$ respectively.

On the other hand, the columns that are numbered beginning from 1 to 5 is representing the change of total costs against shear strength angles. It has to be noted that the numerical boundary values of the vertical axes of the graphs are different from each other. It is clear to say that the increase of external loading conditions leads to rise the total costs. But the incremental steps of total costs are dedicated to the change of soil strength. The increase of soil shear strength causes to decrease the relative cost change between the identified loading conditions. According to the analysis performed in the context of this paper, the maximum relative total cost change is occurring 49% rate and it comprised for the increasing excavation depths via the smallest shear strength angles (for example, the case of H=8 m and Φ=28°). In addition to this, the relative cost change for 4 meters is incontrovertibly important. The increase of soil shear strength from 28° to 38° leads relative cost change rates to decrease 37% to 25%. In such a case that evaluating the same external loading conditions for different shear strength values causes to change relative costs. The relative cost change is 34% for the case that the excavation depth is both 4 and 8 meters and the surcharge loading is constant 20 kPa. The absence of external loading causes to decrease the relative difference between the costs. In the case that the increase of friction 28° to 38° leads the relative difference change to become 27% for both excavation depths. Fig. 4 illustrates the total cost change against the unit weight of soil. Two different soil shear strength angles are selected to interpret the dual effects of soil characteristics. Soil unit weight is assumed to be 15, 16, 17, 18, 19, 20 kN/m³ respectively. The results of the consideration of the increase of the soil unit weights individually and the comparability of them with the smallest value of the selected unit weights show a uniform increment of total costs with the increasing density. For the constant excavation depth H=4 m, the relative total cost change for Φ=30°, begins with 3% for γ=15 kN/m³ and reaches 25% for γ=20 kN/m³. The increase of excavation depth to 8 meters causes to rise relative cost change 5% to 29 for γ=15 kN/m³ to 20 kN/m³ respectively. Generally, it can be said that the increase of soil unit weight with the decrease of soil strength causes to raise the material costs. In Fig. 5 the change of total costs against the ultimate soil base pressure is shown due to the change of excavation depths. Excavation depths have been considered 4 meters and 8 meters respectively and other design variants are taken as constant values. The unit weight of soil is assumed to be 19 kN/m³, the shear strength angle is 35° and no external load application is occurred. Ultimate base pressure is representing an upper boundary for foundation bearing pressure which is used to control bearing capacity failure of structures supported on or in soils. This failure control is conducted by the comparison of the calculated ultimate value of base pressure with the envisaged value of bearing capacity of soil. The calculated value of base pressure has to be smaller than the ultimate bearing pressure of soil.

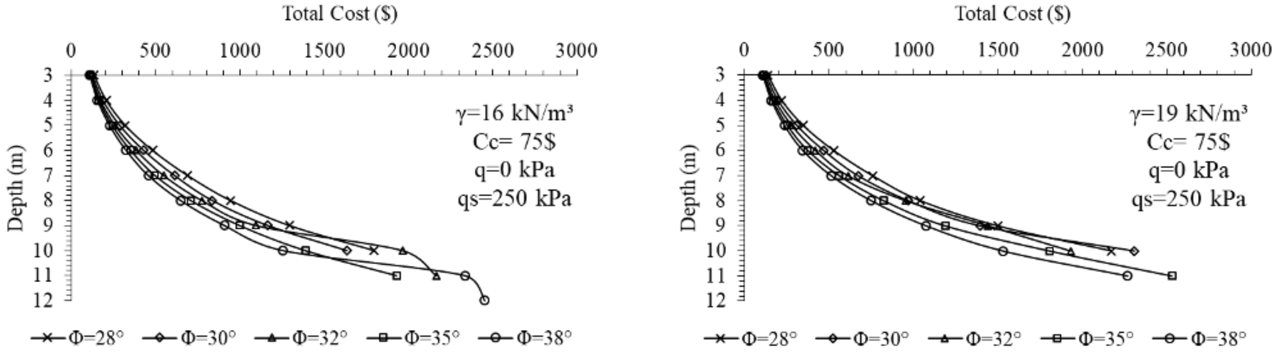

Fig. 2. Change of total cost against excavation depth and internal friction angle.

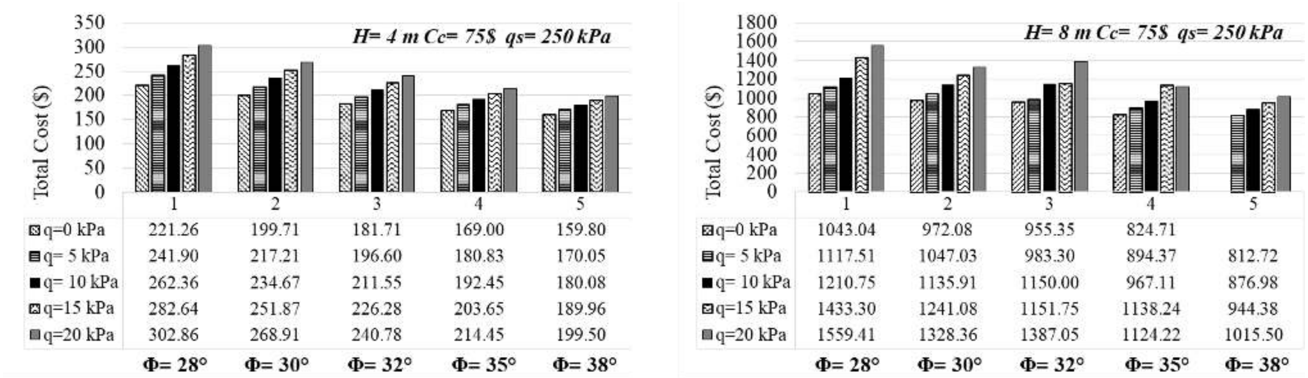

Fig. 3. Change of total cost against surcharge loading and internal friction angle.

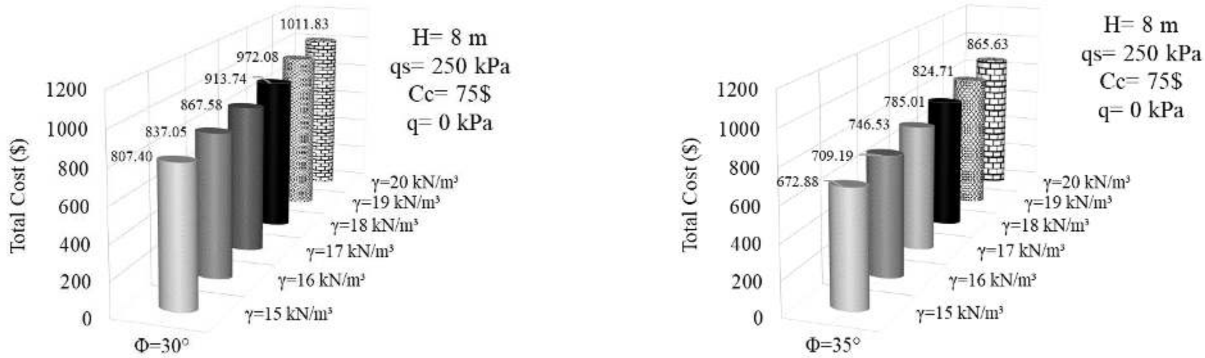

Fig. 4. Change of total cost against the unit weight and internal friction angle of soil.

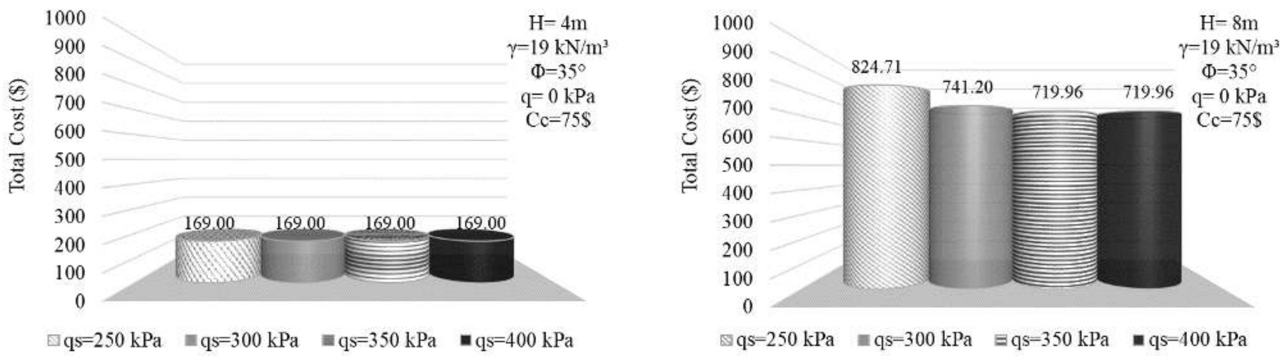

Fig. 5. Change of total cost against the ultimate soil base pressure and the excavation depth.

In case that the excavation depth is selected 4 meters, the change of ultimate bearing pressure hasn't got any effect on the cost of the system. This condition is happened due to the minority of the obtained design section weights with optimization technique. It can be said that the optimized structural design not causes to reach the ultimate base pressure of the soil medium for smaller excavation depths. But the increase of the excavation depth leads the behavior tendency to become dependent on the ultimate bearing pressure of the soil based on the increasing area of the structural design. The increase of the envisaged ultimate soil bearing pressure causes the design to become narrow and cost effective until reaching a boundary value. It can be said that after 350 kPa value of ultimate bearing pressure (from Fig. 5) the design of the system is not needed to be changed. After 350 kPa of ultimate bearing pressure the system is not needed to be changed and the cost is constant and equal to 720$. The increase of ultimate soil bearing pressure from 250 kPa to 350 kPa reduces the total costs of the structural design approximately 15%.

Step 2: The change of wall sizing:

The change of wall sizing based on optimal design of L-shaped walls have been evaluated by the use of the change of foundation dimensions. Foundation width and thickness is used as affected design parameters from variants of this paper. In Fig. 6 the change of wall base width against soil shear strength angle is illustrated with change of excavation depths. Two different excavation depths are assumed to be used to being a reference (H= 4 and 8 meters). The unit weight of the soil is assumed to be 16 kN/m^3 and the ultimate soil bearing pressure is selected 250 kPa as a constant. The absence of external surcharge loading is taken into consideration and evaluations are done according to the change of shear strength angle. In Fig. 6, it can be said that doubling the depth of excavation affected the base width at a similar rate. The change of internal friction angle for the cases that are in prospect hasn't got a significant effect as the change of excavation depth on the dimensions of foundation base. In such a case that is assumed to stay the same excavation depth, the influence of the change of the shear strength angle between the upper and lower limits is nearly calculated 33%. In addition to this, the change of the width of the foundation is nearly calculated 52% for the cases that the change of excavation depth is evaluated based on a constant value of the shear strength angle.

As a result, it can be seen from Fig. 6, the duplication of the excavation depth causes to twice the wall base width. In Fig. 7, the change of wall base thickness is illustrated against the change of shear strength angle and excavation depth. The values that are assumed to be constant for the previous case is taken at the same for Fig. 7. The change of internal friction angle for H=4 meter condition, hasn't got any effect on the design of the thickness of the foundation. But the deepening of the excavation depth causes to increase the thickness of the foundation base to ensure stability conditions because only the rise of the width of the foundation cannot supply the essential resistance that are required for the structural safe design. For the smallest internal friction angle (Φ=28°), the duplication of the excavation depth causes to increase the thickness of foundation twice and besides this the increase of shear strength angle to the envisaged highest value (Φ=38°) causes to increase the thickness 25%. In Fig. 8 and Fig. 9, the effect of the change of the soil unit weight on the dimensions of the wall is investigated for 4 and 8 meters excavation depths respectively. Shear strength angle (Φ=28°) and ultimate soil bearing capacity (q_s=250 kPa) is assumed to be constant and the absence of external load application is evaluated. In Figs. 8 and 9, it is clear to say that the change of foundation width is dominant than the changes in foundation thickness based on the difference of unit weight of soil. Fig. 8, shows that the increase of soil unit weight leads to the increase of foundation width 6% and the foundation thickness is not affected by the difference of soil unit weight. But in Fig. 9, it can be seen that the change of soil unit weight changes both the foundation thickness and the foundation width with 6% level. Figs. 10 and 11 represents the change of soil base ultimate bearing pressure to the wall dimensions for the conditions that the excavation depth is assumed to be 4 and 8 meters respectively. The ultimate bearing pressure values are variants of the cases and they have selected 250, 300, 350 and 400 kPa. The constant parameters of the case are selected the unit weight of soil (19 kN/m^3), the shear strength of soil (Φ=35°) and the absence of external load application is taken into consideration. In Fig. 10, it will be proper to say the change of ultimate bearing pressure is an ineffective design parameter for relatively shallow excavation depths. But Fig. 11, represents a significant influence of ultimate bearing pressure on the design for relatively deep excavation depths for the selected cases. Due to Fig. 11, the required thickness and width of the wall base are decreased, by increasing the ultimate bearing pressure. Analysis that is conducted to obtain the change of external load magnitude on the design shows that the thickness of the foundation is not affected by loading magnitude. Therefore in Fig. 12, only the change of foundation width is shown for different external load applications. The change of foundation width is demonstrated with the dual evaluation of both shear strength angle and excavation depth. The excavation depth has been selected 4 and 8 meters like the before mentioned other cases. The ultimate soil bearing pressure is 250 kPa and the unit weight of the soil is selected 19 kN/m^3. The absence of external loading and 5, 10, 15 and 20 kPa external loading conditions are treated respectively in the analysis. In Fig. 12, the vertical axes of the given graphs are different. In such a case that the excavation depth is 4 meters and the shear strength angle is 28°, the increase of external loads from 0 to 20 kPa causes to enlarge the foundation depth by 24%. If the shear strength angle increased to 38°, the increase of external loads from 0 to 20 kPa leads the foundation width to enlarge by 19%. The deepened the excavation depth results an important influence of external loads to the width of the foundation. In cases which the excavation depth is 8 meters and internal friction angle is selected 28°, the rise of external load from 0 to 20 kPa produces an increment on the foundation width by 47%. If the shear strength angle is assumed 38°, the rise of the external load causes to increase the dimension of foundation by 33%.

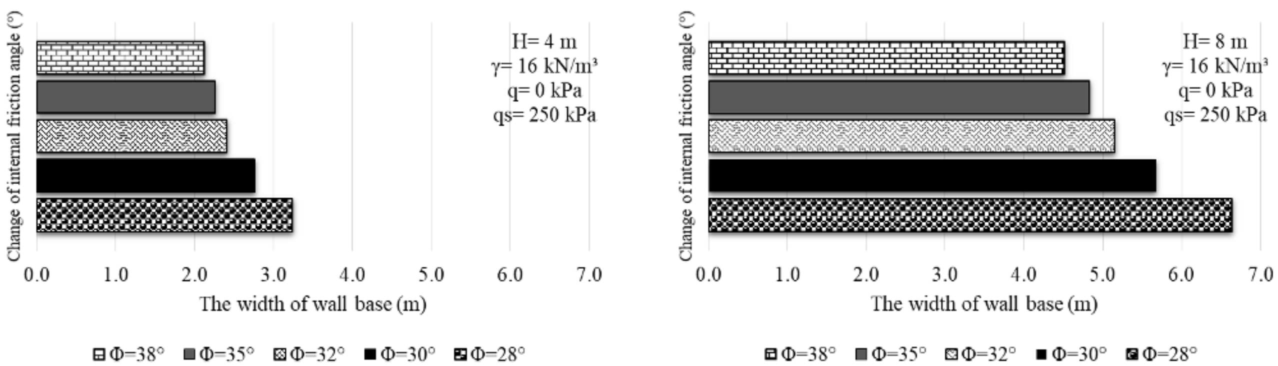

Fig. 6. Change of the wall base width against soil shear strength angle and the excavation depth.

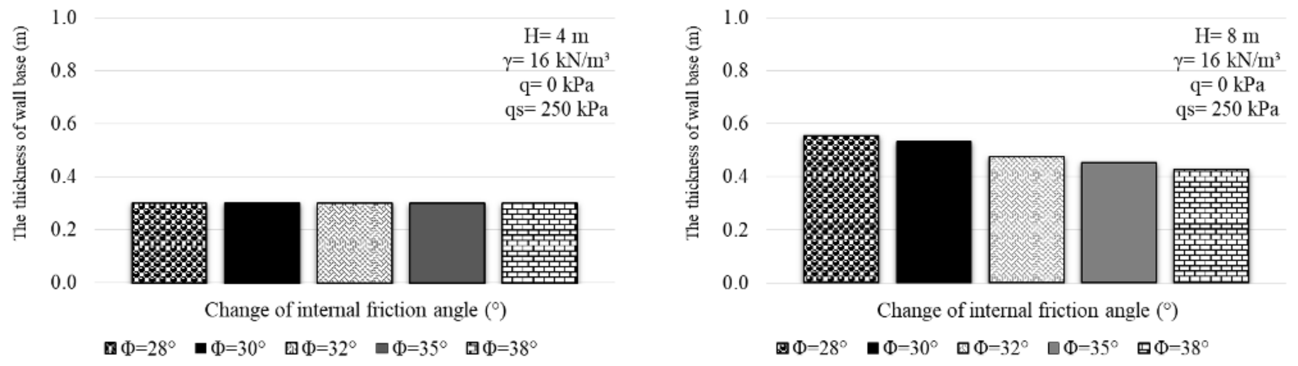

Fig. 7. Change of the wall base thickness against soil shear strength angle and the excavation depth.

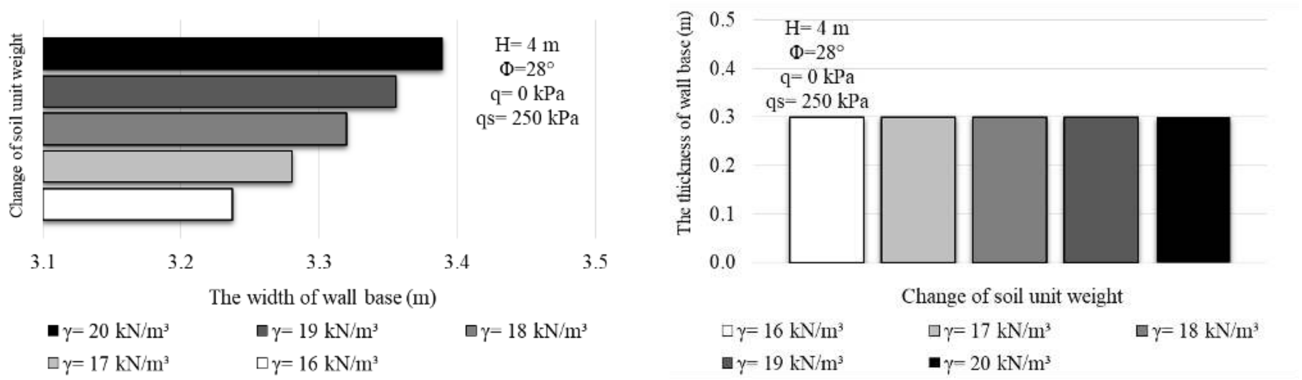

Fig. 8. Change of wall sizing against soil unit weight (H=4 m).

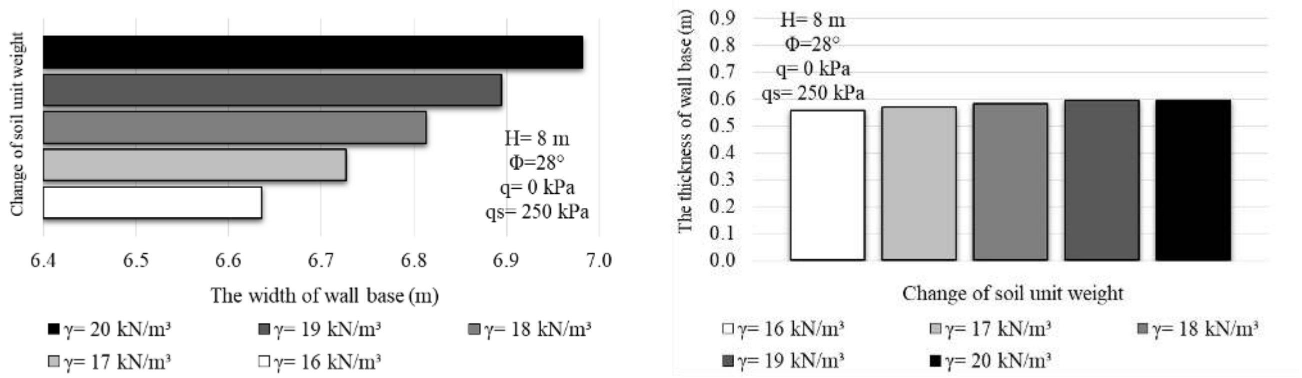

Fig. 9. Change of wall sizing against soil unit weight (H=8 m).

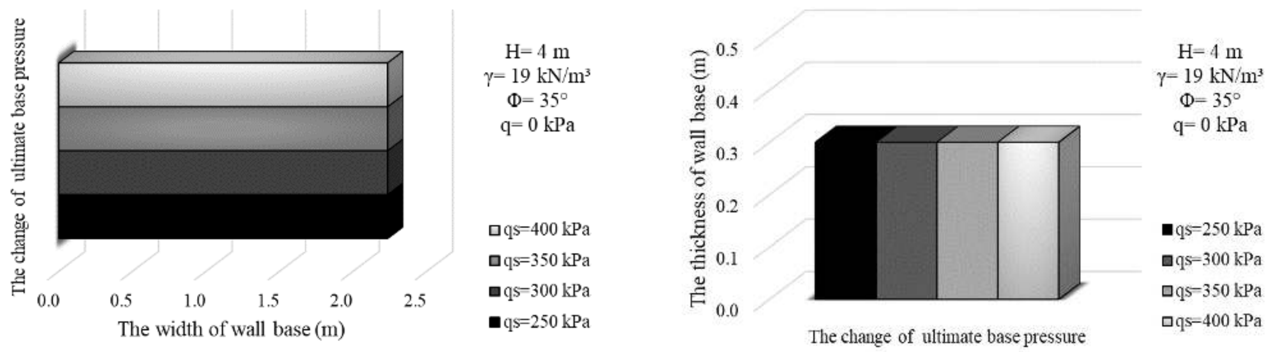

Fig. 10. Change of wall sizing against the ultimate base pressure (H=4 m).

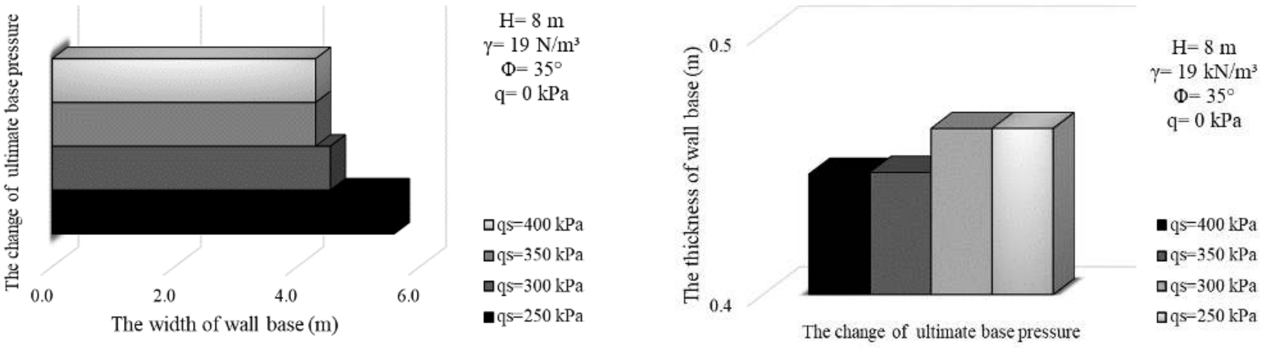

Fig. 11. Change of wall sizing against the ultimate base pressure (H=8 m).

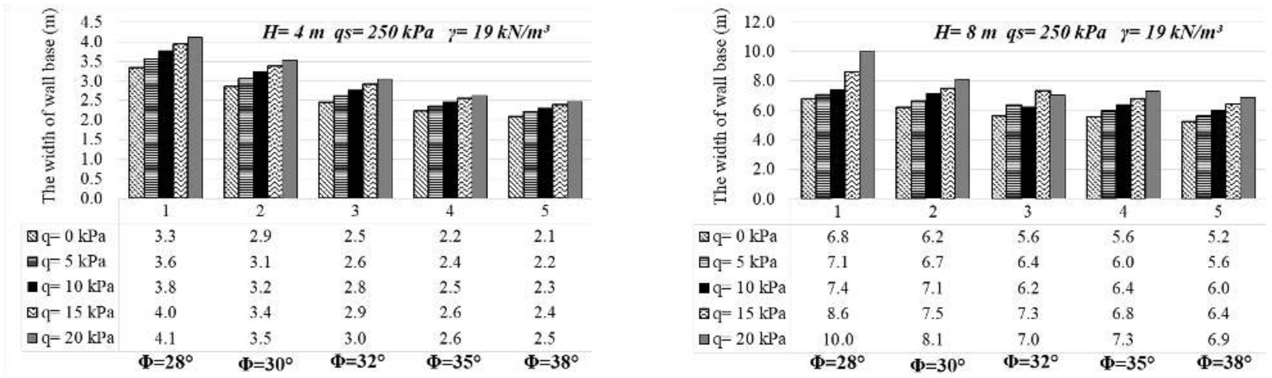

Fig. 12. Change of the width of the wall base against surcharge loading, internal friction angle and the excavation depth.

5. Conclusions

In the present study, innumerous optimization analysis is performed with Jaya Algorithm to find the cost effective sizing of L-shaped restricted reinforced concrete retaining walls. The vital point of the study is to investigate the influence rates of design parameters on the optimization process of the walls based on the applicable restrictions of L-shaped walls. Five different shear strength angles, four different ultimate base bearing pressures and five different soil unit weights have been used to derive various design cases to generate the embedding soil medium of retaining structures. Besides these, five different external surcharge loading condition is formed and five different excavation depths are compared with each other to control the parameter selection importance on design and cost balance. The analysis results have shown that the most influencer parameter on the design of L-shaped reinforced concrete retaining walls is the excavation depth. The deeper the excavation depth leads to widen the foundation width and causes the increase of costs in relation with the sizing. Besides this the shear strength angle has been found as the significant soil parameter which is changing the design entirely. The foundation width and the thickness of the foundation base is both affected by only the change of soil friction for the constructions done in granular soils. The unit weight change of the soil medium has only an effect on the width of the foundation. The increase of the soil unit weight causes to widen the foundation due to the increased lateral earth pressures. The effect of ultimate base bearing pressure can be the least effective soil parameter to obtain the optimal design. But the effect of the ultimate bearing pressure might have been relatively significant if the wall construction reached a limit height which can be changed according to the design requirements. The increase of the wall height has led the increase the vertical resisting forces with the increase of wall weight and this situation also has increased the lateral soil pressures. Besides this condition, the existence and increase of external surcharge loads cause to decrease the safety value against sliding, overturning and adequateness of ultimate soil base pressure. Because the increase of external loads at the backfill side of the wall system causes to increase the lateral forces and attain the structure unstable condition. Differently from this mentioned conclusion, it is obvious to say that the design of L-shaped walls are separated from T-shaped walls by the restriction of foundation base. Due to this restriction, it is hard to acquire essential structural strength and related geotechnical design to resist lateral earth with classical pre-design methods. So, this study represents the advantage of optimization techniques that are providing compatible and time-effective solutions for observing the limitations of design. In this study, the analysis is conducted for the excavation depths between 4-12 meters but it cannot be able to obtain an appropriate design that is supporting 9, 10 and 12 meters excavation depth due to the lack of technical adequateness (either geotechnical or static design safety requirements) within the limits of defined design variables. In addition to all these, the present study is original because of the usage of a recently developed algorithm Jaya to a special type of a retaining wall. So it can be assumed that the present study is representative to show the applicability of this algorithm to special retaining wall designs. The advantage of optimization application according to the other limit state based retaining wall design software is to investigate the safe design requirements and to discuss the influencer parameters with time and cost effectiveness.

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