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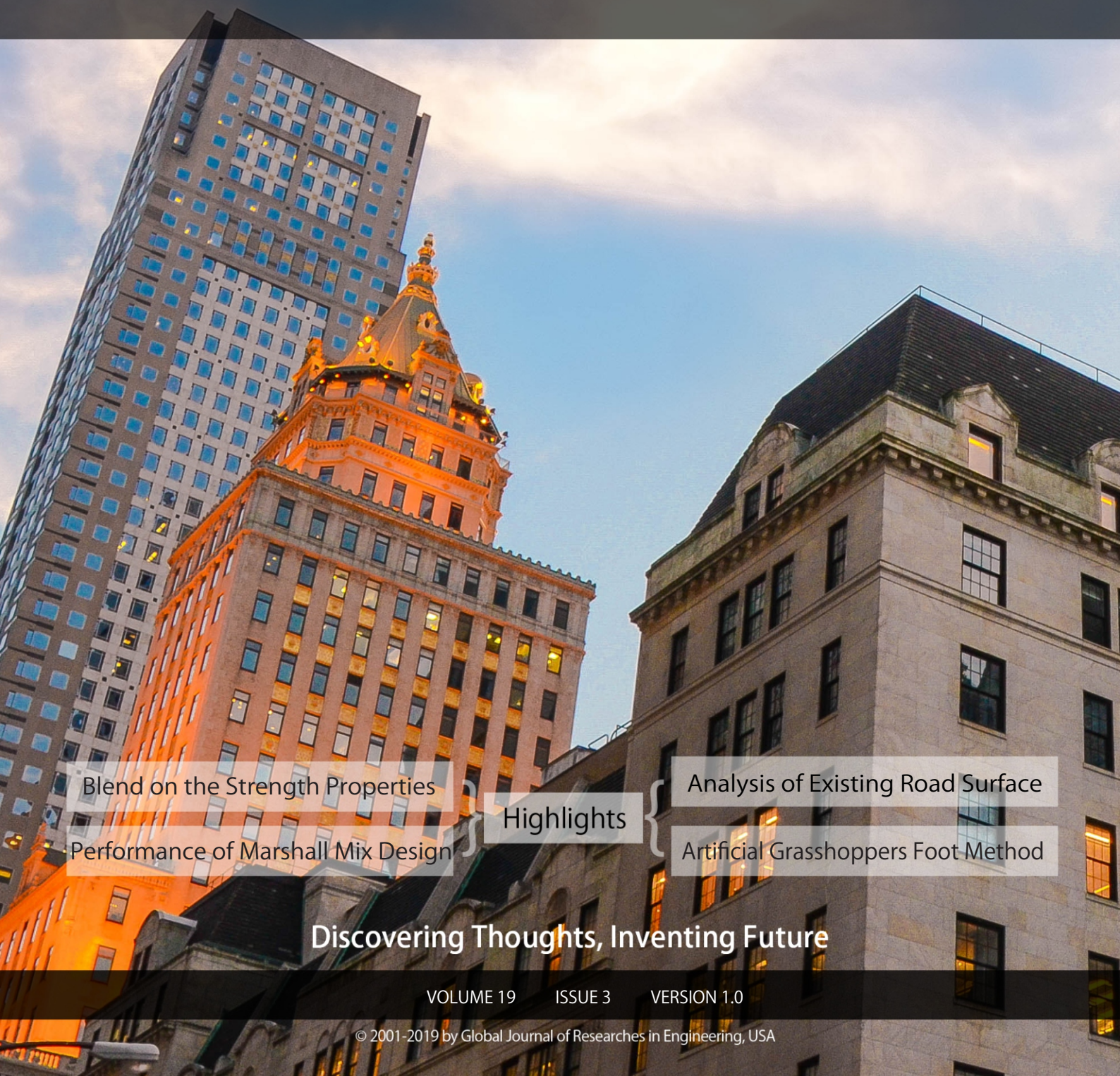

Blend on the Strength Properties

Performance of Marshall Mix Design

Highlights

Analysis of Existing Road Surface

Artificial Grasshoppers Foot Method

Discovering Thoughts, Inventing Future

VOLUME 19 ISSUE 3 VERSION 1.0

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New Method for Static Load Test for Pile Rests in Sandy Soil Underlain by Clay

By Rami Bakr
Delta University

Abstract- There are many cases the use of shallow foundations doesn't fit for bearing capacity considerations. In some of these cases, there are soil layers with high strength properties that exist at shallow depths underlain by soil layers with less strength, and the continuous, suitable layer located at great depth. In these cases, it would be useful to use short piles rests on the functional shallower soil layers as bearing layer. These layers are either stiff clay layers with high shear strength or sand layers with high friction resistance or a mixture of both. Due to the presence of weak soils under the bearing layer, this research focuses on the behavior of pile that rests in sand underlain by clay soil. Two sites selected for this study, the first is located in Mansoura city while the other is in Gamasa, and both sites located in the Nile Delta Region of Egypt. In situ and laboratory tests were carried out to determine soil properties. Static load tests conducted on several piles. Numerical simulation for the static load test then performed for each case.

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New Method for Static Load Test for Pile Rests in Sandy Soil Underlain by Clay

Rami Bakr

*Abstract -*There are many cases the use of shallow foundations doesn't fit for bearing capacity considerations. In some of these cases, there are soil layers with high strength properties that exist at shallow depths underlain by soil layers with less strength, and the continuous, suitable layer located at great depth. In these cases, it would be useful to use short piles rests on the functional shallower soil layers as bearing layer. These layers are either stiff clay layers with high shear strength or sand layers with high friction resistance or a mixture of both. Due to the presence of weak soils under the bearing layer, this research focuses on the behavior of pile that rests in sand underlain by clay soil. Two sites selected for this study, the first is located in Mansoura city while the other is in Gamasa, and both sites located in the Nile Delta Region of Egypt. In situ and laboratory tests were carried out to determine soil properties. Static load tests conducted on several piles. Numerical simulation for the static load test then performed for each case. By comparing the results of both the static load tests and the numerical simulation of real-life loading, (RLL), the pile behavior described by the standard method of static load test, (SSLT), according to ASTM D-1143, is significantly exaggerated. This study proposes a new technique called Modified Quick Load Test (MQLT1.3). The proposed method is validated by numerical simulation and field static load tests. Although the proposed process is less time-consuming, less expensive, it accurately represents the real pile behavior in the sand layer underlain by clay.

Résumé- Dans de nombreux cas, il existe des couches de sol avec des propriétés de haute résistance existent à de faibles profondeurs qui peuvent être utilisés comme portant des couches pour les pieux surtout quand il ya des couches de sable continue à de grandes profondeurs. Ces couches sont des couches d'argile rigides avec force de cisaillement ou de sable couches à haute résistance à la friction ou un mélange des deux. En raison de la présence de sols faibles sous la couche de roulement, cette recherche se concentre sur le comportement de la pile qui repose dans le sable reposant sur un sol argileux. Deux sites ont été choisis pour cette étude, la première se trouve Mansoura ville tandis que l'autre est en Gamasa et les deux sites sont situés dans la région du delta du Nil de l'Egypte. In situ et au laboratoire essais ont été réalisés afin de déterminer les propriétés du sol. Essais de charge statique ont été réalisés sur uncertain nombre de piles. La simulation numérique pour test de charge statique a ensuite été réalisée pour chaque cas. En comparant les résultats des deux essais de charge statique et la simulation numérique de la vie réelle de la charge (RLL), il a été constaté que le comportement de la pile décrite par la méthode standard de test de charge statique, (SSLT), selon la norme ASTM D -1143, est nettement exagéré. Une nouvelle méthode appelée Modifié test de charge rapide (MQLT1.3) est proposé par cette étude. La nouvelle méthode est validée par des tests de charge statique de simulation et de terrain numériques. Bien que la nouvelle méthode est moins de temps, moins cher, mais ça représente bien le comportement des pieux réel dans la couche de sable reposant sur de l'argile.

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I. Introduction

The static load test has been regarded to be the most reliable test method because the actual pile-soil behavior directly obtained from the static load test. In delta regions, due to its lower level, the subsurface soil consists of successive layers of sand, clay and silt sediments. These deposits are usually built up from a mix of these soils. In many cases, thick sand or stiff clay layers exist underlain with other soft soils at relatively shallower depths. These soils are suitable as bearing layers for pile foundation with a careful study of the expected settlement. The authors proved that the pile behavior predicted by the current static load test method in clay soil is hugely exaggerated. The author proposed a new technique for the case of pile rests in clay based on numerical and field tests, Bakr, R., et al. 2103 and 2014. This study focuses on the evaluation of the standard static load test (SSLT) method as a tool for the prediction of the pile behavior when it rests in the sand layer underlain by clay. Field load tests and numerical simulation tools are used to evaluate the standard static load test.

II. Test Sites

Two sites 50 km apart located in Egypt Nile Delta region were selected. The first site located in Mansoura city where 13 floors buildings constructed while the other site belongs to Delta University, which exists in Gamasa city on the Medetririan Sea south cost. Figure 1, Shows an image captured from Google earth for both sites. These sites were selected to represent the case of pile rests in sand layer underlain with clay. For site 1, the pile diameter is 0.5m, and its length is 14.5m. For site 2, three pile diameters are used 0.5, 0.6, and 0.8m with the same pile length 8.0m.

Figure 1: Locations of study sites

III. Soil Profile at Study Sites

Two boreholes executed in the first site and fifteen boreholes performed in the second site. Figure 2 shows both borehole and static load test locations for site 2. Samples were collected from boreholes every meter, and necessary tests were carried out. The final water level found at depths 1.5 and 1.20 meter from the existing ground for sites 1 and 2 respectively. The soil at site-1 consists of the following layers:

1. From 0.0 to 1.0 m fill of dirty grey loamy clay followed by fill of dirty loamy sand from 1.0 to 2.0m.
2. Grey soft to medium clay exists at depth 2.0 to 6.0 m followed by dark grey very soft to soft silty clay from 6.0 to 8.0 m.
3. From 8.0 to 11.0 m dark grey fine silty sand, trace clay, and trace mica.
4. From 11.0 to 15.0 m grey medium/coarse sand, and trace silt. These are followed by grey medium/fine sand, with traces of silt from 15.0 to 18.0 m.
5. Grey soft to medium silty clay and little fine sand exists at depth 18.0 to 21.0 m followed by brown soft to medium silty clay from 21.0 to 23.0 m.
6. Soft brown sandy silty clay with traces of crushed cemented sand exists at depth 3.0 to 24.0 m.
7. From 24.0 to 25.0 m yellowish grey medium/fine sand with traces of silt.

The soil profile for site 2, shown in Figures 3. The main properties of soil for both sites as obtained from the lab and field tests for site-1 shown in Tables 1 through 3. Table 4 summarizes the soil properties for site 2.

IV. Estimation of Theoretical pile Bearing Capacity

The theoretical ultimate bearing capacity and the corresponding settlement contributions for each pile diameter were determined using the static formulas of the Egyptian Code of Practice for Deep Foundation, as shown in Table 2.

V. Full-Scale Static Load Tests According to (SSLT)

No static load tests were conducted at site-1, while nine field static load tests conducted at site-2. Four static load tests executed for a diameter of 50 cm, (T1, T2, T4, and T8), three tests for diameter 60cm, (T-3, T-5, and T-9), and two tests for diameter 80cm (T-6, and T-7).

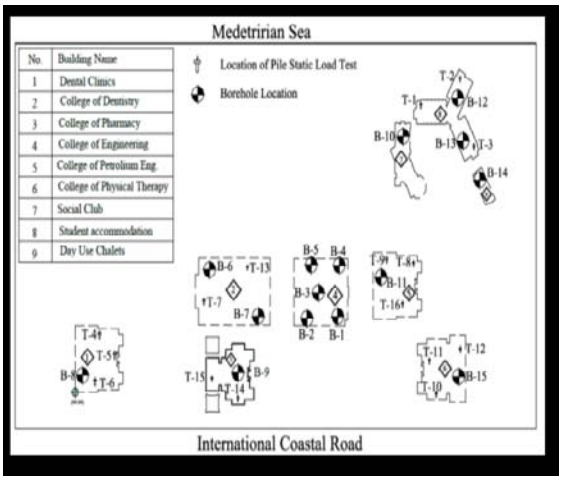

Figure 2: The layout of Delta University (site 2) showing the location of boreholes and static load tests.

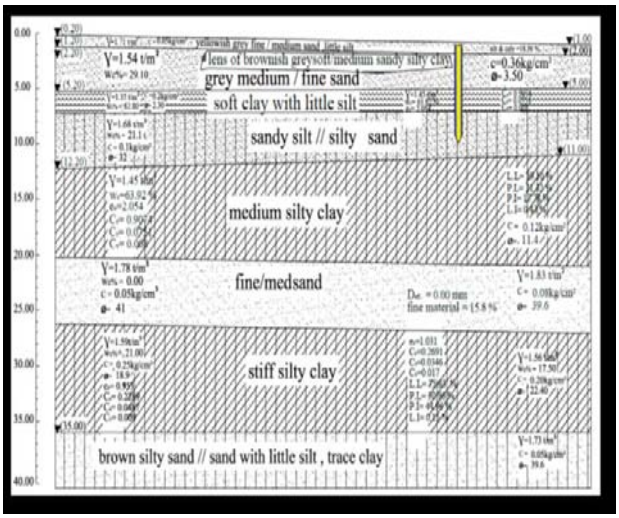

Figure 3: Soil profile at site-2.

VI. Numerical Simulation

a) Introduction

Constitutive models are capable of predicting not only the onset of failure but also the complete stress-strain response leading up to failure. Three constitutive models used in this study; Mohre-Coulomb, Hardening Soil, and Soft Soil Creep.

Although the elastic-plastic Mohr-Coulomb model takes the increase of stiffness with depth into account, the Mohr-Coulomb model (MC) does neither include stress dependency nor stress-path dependency of stiffness or anisotropic stiffness.

The Hardening Soil model (HS) was developed based on the theory of plasticity instead of the theory of elasticity. This model includes soil dilatancy and a yield cap; therefore, it is far better than the original hyperbolic model by Duncan and Chang (1970). The hardening soil model includes two types of hardening; shear hardening and compression hardening. The main characteristics of this model as reported in literature are:stress dependent stiffness according to power law (defined by parameter, m), plastic straining due to primary deviatoric stress (defined by parameter, Eref50), plastic straining due to primary compression (defined by parameter, Erefoed), elastic unloading/reloading (specified by parameter, Erefur&ur),and failure according to the Mohre-Coulomb model (represented by parameters:c,,).

Soft Soil Creep model (SSC) was proposed by Brink greve et al., (2006) as an extension of the original Cam Clay Model by taking the time dependency of soft soil strains into account. The critical characteristics of SSC model are stress-dependent stiffness, the distinction between primary loading and unloading-reloading, time-dependent compression, the memory of preconsolidation pressure, failure behavior according to the Mohr-Coulomb criterion. Yield surface adapted from the Modified Cam Clay model.

b) Numerical Simulation of Pile Static Load Test and Real-Life Loading

Numerical simulation was carried out of pile static load tests according to both standard method (SSLT) and Real-life Loading (RLL). Plaxis 3D Foundation used as a finite element software in the numerical analysis. The results of the numerical simulation of SSLT and RLL were compared with the results of the full-scale static load tests to evaluate the current method as a tool for the prediction of time-dependent behavior of pile that rests in sand layer underlain by clay. MC, HS, and SSC models used in the evaluation of site-1. For site 2, From the analysis, the author noted that HS model gives a very exaggerated settlement concerning the full-scale tests; therefore, these cases excluded from the analysis. For site-2, MC was assigned to non-cohesive soil while SSC assigned to cohesive soil. As shown in Figures 4 through 6 and figures 7 through 9, the author noted that the results of both full-scale tests and numerical simulation of the standard static load test method are consistent. The author pointed out that the standard static load test method (SSLT) gives significantly exaggerated pile behavior for the case of pile rests in sand underlain by clay w. r. t. RLL.

c) Development of New Method for Pile Static Load Test by Numerical Simulation (MQLT1.3)

Numerical simulations for several loading scenarios were experienced to capture the pile behavior for the proposed load test that simulates its real behavior. Accordingly, a new method for the static load test called MQLT1.3 proposed as follows:

- Test load equals 1.30 times the design load.
- six equal load increments/decrements executed.
- Each increment/decrement equals 0.25 the design load except the last increment, which equals 0.05 the design load.
- The time periods for maintaining the load increments during loading stage are 0.5, 0.5, 1.0, 1.0, 1.0, and 2.0 hours and 0.25, 0.25, 0.25, 0.25, 0.25, and 2.0 hours for unloading decrements.

Numerical simulation was further conducted on the same cases of study, including both sites 1 and 2 but according to the new method MQLT1.3. Figures 10 to 12 portrays a comparison between the results obtained from numerical simulation for SSLT, RLL, and MQLT1.3 for the case of site 1 by MC, HS, and SSC, respectively. The results showed that the new method gives consistent pile behavior to that obtained from RLL.

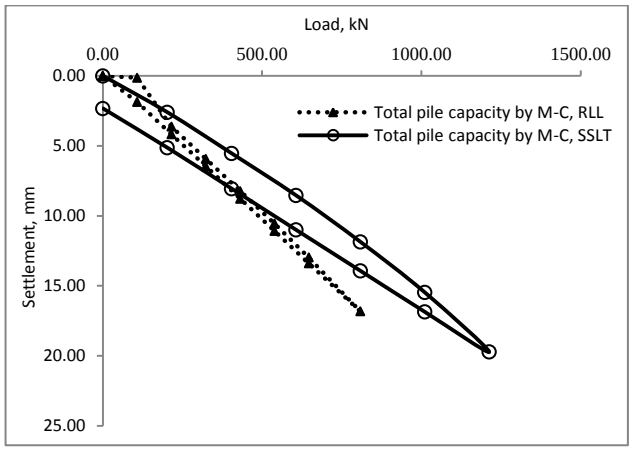

Figure 4: Load versus the settlement from the numerical simulation by MC of SSLT, and RLL for piles with 50 cm diameter rest in sand layer underlain by clay at site 1.

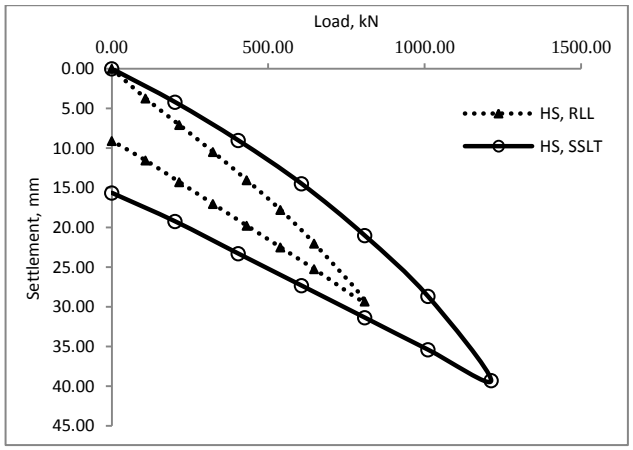

Figure 5: Load versus the settlement from the numerical simulation by HS of SSLT, and RLL for piles with 50 cm diameter rest in sand layer underlain by clay at site 1.

VII. Validation of the new Method (MQLT1.3) by Field Static Load Tests

Seven field load tests were conducted at site 2, according to MQLT1.3, to validate the numerically developed static load test method. The diameters of tested piles are 0.50, 0.60, and 0.80 meters. The test piles were selected at different locations to represent the soil conditions in the whole site. Figures 13 to 15 show the load versus settlement relationships obtained from both numerical simulation and full-scale static load tests by MQLT1.3 for diameters 50, 60, and 80 cm, respectively. The author noted that the pile behavior predicted using the numerical simulation either for MQLT1.3 or RLL is more consistent with that obtained from the full-scale static load tests conducted according to the new method (MQLT1.3) concerning the standard static load test (SSLT).

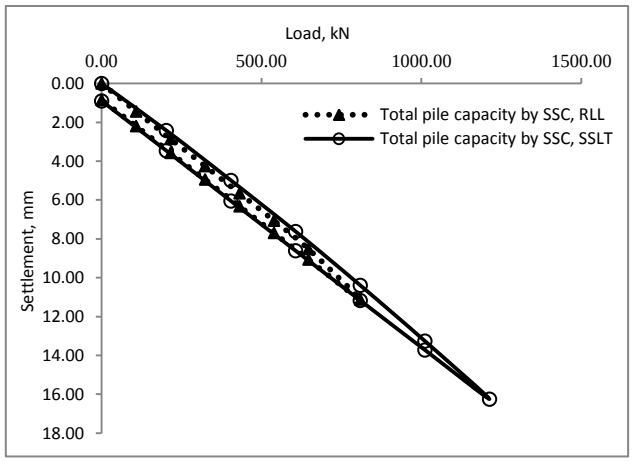

Figure 6: Load versus settlement from the numerical simulation by SSC of SSLT, and RLL for piles with 50 cm diameter rest in sand layer underlain by clay at site 1.

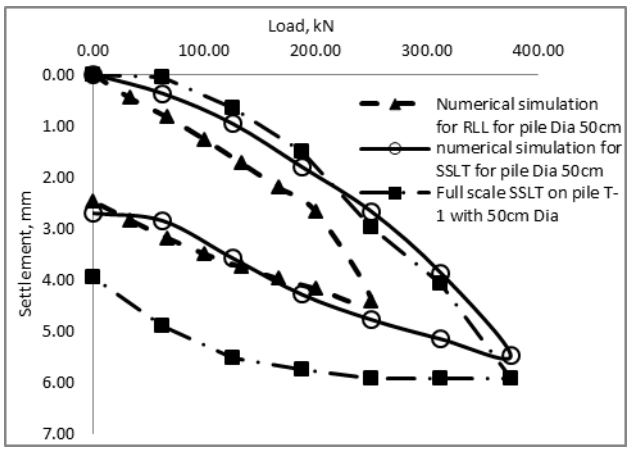

Figure 7: Load versus settlement from full-scale tests, numerical simulation of SSLT, and RLL for piles with 50 cm diameter rest in the sand layer at site 2.

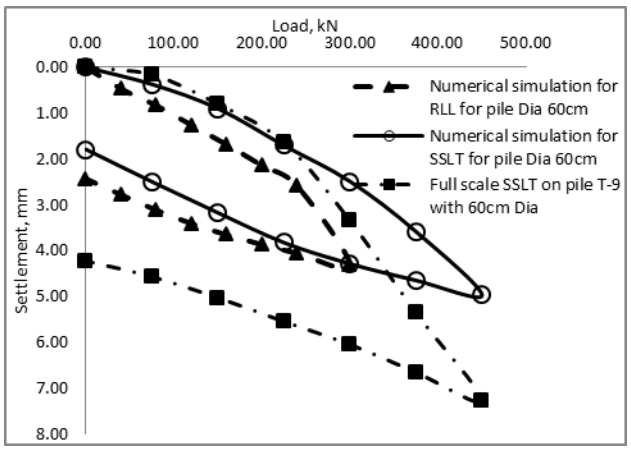

Figure 8: Load versus settlement from full-scale tests, numerical simulation of SSLT, and RLL for piles with 60 cm diameter rest in the sand layer at site 2.

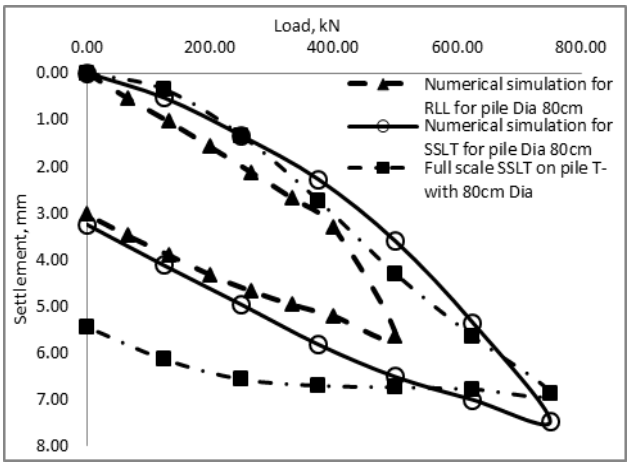

Figure 9: Load versus settlement from full-scale tests, numerical simulation of SSLT, and RLL for piles with 80 cm diameter rest in the sand layer at site 2.

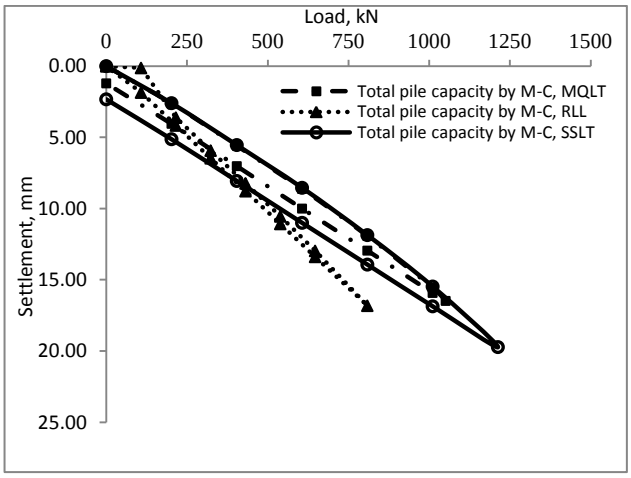

Figure 10: Comparison between numerical simulation by MC for MQLT1.3, RLL, and SSLT for pile with diameter 50 cm rests in sand underlain with clay at site 1.

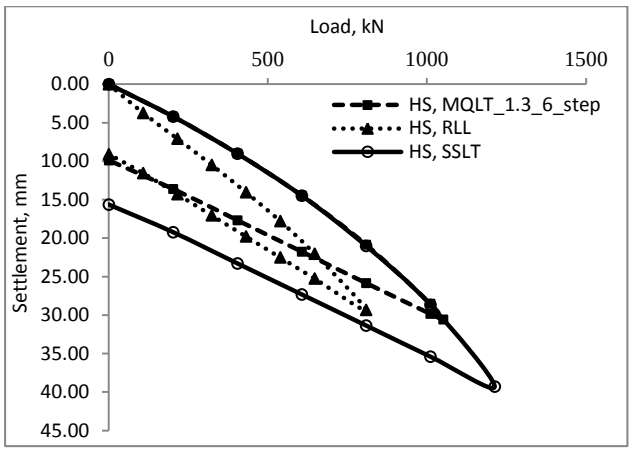

Figure 11: Comparison between numerical simulation by HS for MQLT1.3, RLL, and SSLT for pile with diameter 50 cm rests in sand underlain with clay at site 1.

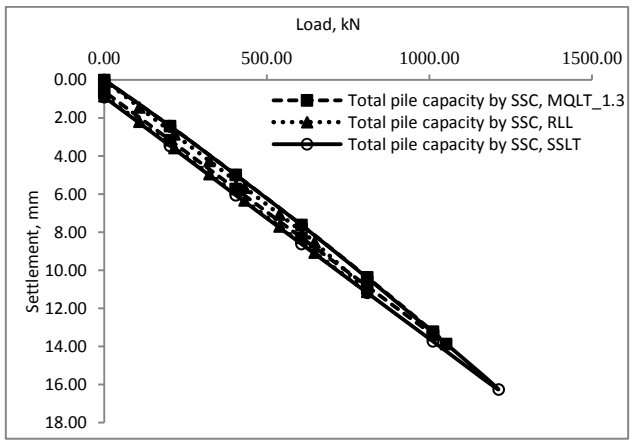

Figure 12: Comparison between numerical simulation by SSC for MQLT1.3, RLL, and SSLT for pile with diameter 50 cm rests in sand underlain with clay at site 1.

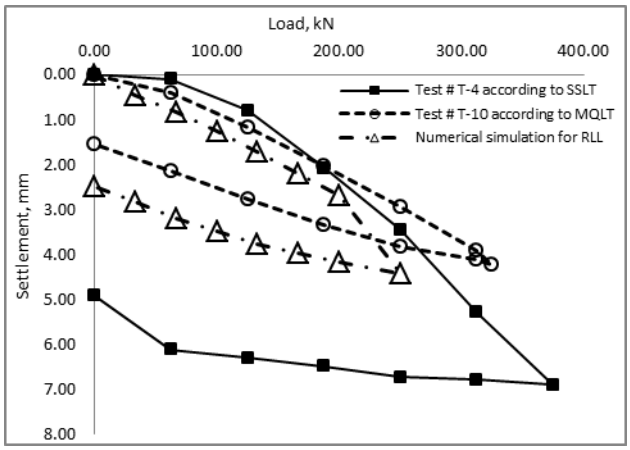

Figure 13: Comparison between numerical simulation for RLL and field test results by SSLT and MQLT1.3 for pile with diameter 50 cm rests in sand underlain with clay at site-2.

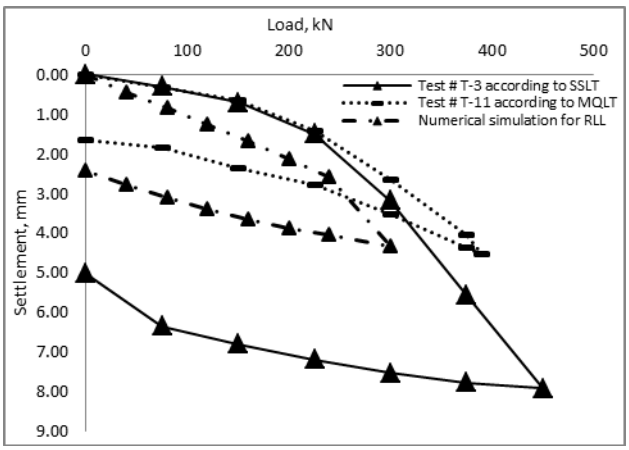

Figure 14: Comparison between numerical simulation for RLL and field test results by SSLT and MQLT1.3 for pile with diameter 60 cm rests in sand underlain with clay at site-2.

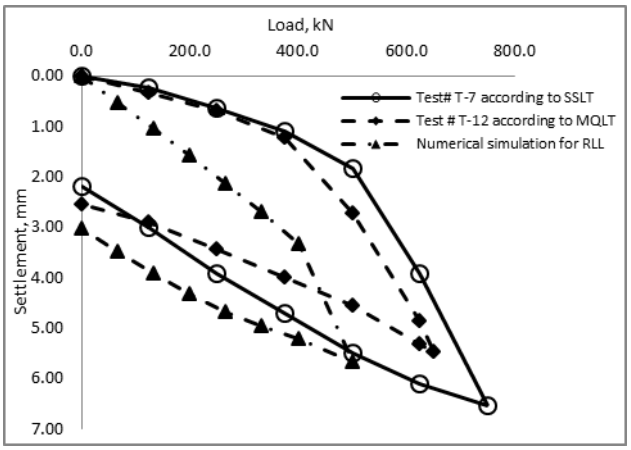

Figure 15: Comparison between numerical simulation for RLL and field test results by SSLT and MQLT1.3 for pile with diameter 80 cm rests in sand underlain with clay at site-2.

VIII. Analysis of test Results

By comparing the results obtained from both numerical analysis and field tests, the author noted that the pile behavior described as non-linear plastic. The total settlement occurred at the end of the loading phase by MQLT1.3 equals 0.95 to 1.05 times that predicted by the RLL based on SSC simulation. The total settlement by SSLT represents 1.15 to 1.89 times that determined by the numerical analysis using SSC model for RLL. The static load test results by MQLT1.3 were used to predict the ultimate pile capacity by the extrapolating theories. The average values of both Brinch Hansen and Chin Konder determined according to the Egyptian code of Practice for Deep Foundation 202/2001. Table 6 presents a comparison between the theoretical pile capacity and the extrapolated. The author noted that the new method MQLT1.3 could predict the pile behavior accurately in sand underlain by clay. The working load determined from theoretical capacity by dividing by 2.0 on condition that this load includes the earthquake and other non-permanent loads. The working load defined from the load tests by dividing the extrapolated pile capacity by 1.5.

IX. Conclusions

From both numerical and field tests, the following conclusions extracted:

a) The new method called the modified quick load test method (MQLT1.3) accurately represents the real pile behavior.
b) The numerical simulation using the MC model assigned to non-cohesive soil and SSC model appointed to soft soil accurately predict the pile behavior is bearing on sand layer underlain with clay.
c) The standard static load test method (SSLT) gives a significantly exaggerated pile behavior for the case of pile rests in sand layer underlain with clay.

Table 1: Properties of clay at site 1

Depth, m	WC%	GS	d	eo	sat	C, KN/m2	°	K*10-4 m/min
3.00	35.18	2.70	17.17	1.088	17.81	34.00	19.10	0.0006
5.00	34.55	2.72	16.58	1.169	17.61	42.00	18.00	0.0004
7.00	70.60	2.71	15.21	1.976	15.43	6.00	4.90	0.008
18.00	27.84	2.73	17.85	0.917	18.66	19.00	16.80	0.0006
21.00	38.02	2.73	16.66	1.215	17.45	31.00	25.40	0.0006
23.00	36.88	2.73	18.34	0.995	18.29	9.00	3.70	0.008

Table 2: Sand properties at site 1

Depth	d		sat		compacted sandy soil		uncompacted sandy soil	K, m/min	
peak values					residual values				
C, kN/m2	ϕ°		C, kN/m2		ϕ°		C kN/m2	ϕ°	
8.00	16.58	16.58	6.00	42.90	0.00	38.00	0.00	36.70	0.0006
15.00	18.15	18.15	0.00	47.00	0.00	37.80	0.00	36.10	0.0137
24.00	17.66	17.66	0.00	43.50	0.00	37.50	0.00	35.00	0.0101

Table 3: Consolidation parameters at site 1

Depth	kN/m3	Wc。%	e。	Cc loading	Cs unloading	Cv cm2/min	mv m2/kN	Pp kN/m2
2.00	18.62	22.11	0.738	0.14127	0.02630	0.027	0.0002	101.00
6.00	16.78	33.33	1.123	0.50155	0.04010	0.009	0.0006	173.00
19.00	18.25	27.34	0.868	0.28247	0.05300	0.009	0.0003	203.00
22.00	17.27	37.62	1.125	0.60649	0.04040	0.026	0.0007	213.00

Table 4: Summary of soil parameters at site 2

	DEPTH, M	d	sat	wc	C	°	eo	Cc	Cs	Cv	Nc	Dr
1	0.00-5.00	14.50	18.00	25 - 85	0.0	3 - 41	1.33 - 2.05	N.A	N.A	N.A	6 - 44	80
2	5.00-7.00	10. 20	13.60	49 - 89	9 - 12	3 - 8	1.16 - 1.50	0.54-0.91	0.075-0.086	0.013-0.035	9-35	N.A
3	7.00-12.00	16.30	16.80	21 - 25	7 - 10	32	1.10-1.30	N.A	N.A	N.A	20 - 58	80
4	12. 00-21.00	15.20	16.30	26 - 50	8 - 22	5 - 22	1.06 - 1.75	0.51-0.68	0.048-0.082	0.018-0.024	31 - 47	N.A
5	21. 00-	13.30	17.95	32	0.0	39	1.10	N.A	N.A	N.A	15 -	80
	25.00										48	
6	25.00-35.00	12.50	15.60	18 - 27	20 - 37	11 - 23	0.87 - 1.24	0.24-0.26	0.025-0.056	0.009-0.04	32 - 45	N.A
7	35.00-40.00	13.30	17.95	32	0.00	40	0.85	N.A	N.A	N.A	40 - 58	80

Where; sat & d = maximum and minimum unit weight (kN/m3), wc = water content (%), C = cohesion in (kN/m2), ° = angle of internal friction, eo = initial void ratio (%), Cc = compression index-loading, Cs = compression index-reloading, Cv = coefficient of consolidation cm2/min), Nc = corrected value of number of blows in SPT, Dr = relative density.

Table 5: Bearing capacity and settlement calculated by static formula

Site	Pile Dia. m	Qb kN	Qf kN	Qu kN	Qw kN	Qt kN	Ss mm	Spp mm	Sps mm	St mm
1	0.50	642	975	1617	808	1212	2.09	23.55	1.18	26.82
2	0.50	389	158	500	250	375	0.56	7.85	0.15	8.55
0.60	560	189	600	300		450	0.53	9.42	0.16	10.11
0.80	719	281	1000	500		750	0.31	24.58	1.63	26.52

Where; Qb = toe resistance, Qf = shaft resistance, Qu = ultimate resistance, Qt = test load, Ss = elastic compression, Spp = settlement due to Qb, Sps = settlement due to Qf, st = total settlement.

Table 6: Comparison Between Pile Capacity By Theoretical Formula And Mqlt1.3

Pile Dia. cm	Test #	Q_{uth} kN	Q_{wth} kN	Q_t kN	S_t mm	S_p mm	Q_{uex} kN	Q_{wf} kN	Q_{wf}/Q_{Wth} %
50	T-10	500	250.00	325	4.22	1.56	420.11	280.07	112.03
	T-11				4.32	1.73	507.34	338.23	112.74
60	T-14	600	300.00	390	4.53	1.64	487.48	324.99	108.33
	T15				4.15	2.72	533.91	355.94	118.65
	T-12				5.47	2.55	767.00	511.33	102.27
80	T-13	1000	500.00	650	5.45	2.43	820.80	547.20	109.44
	T-16				5.61	3.46	867.50	578.33	115.67

Where; Quth = ultimate theoritical pile capacity, Qwth = working load from theoritical pile capacity, Qt = test load, Sp = plastic settlement, Quex = ultimate pile capacity from extrapolating, Qwf = working load from field test.

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Analysis of Existing Road Surface on the Basis of Pothole Characteristics

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Abstract- This project will help to classify the condition of road pavement surface on the basis of characteristics of pothole namely depth, area and volume. Now a days in India there is no specific criteria for road maintains and road construction. Due to no specific criteria any representatives do unnecessary reconstructions or maintenance and vice versa. There is a need for a specific criterion for limiting the expenses made on this. There is need for developing such classification criteria for making choices regarding the maintenance of roads. In this project firstly we select the road and collected the information about there characteristics such as area, volume, depth and perimeter of pothole by using traditional methods but for area we use the android software in which by taking a photograph it will give us the area and perimeter of pothole. Then we have conducted a survey by using google form.

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Analysis of Existing Road Surface on the Basis of Pothole Characteristics

Vishal. L. Solanke [α], Darshan. D. Patil [σ], Aniket. S. Patkar [ρ],
Gajanan. S. Tamrale [ω] & Prof. Amit. G. kale [¥]

Abstract- This project will help to classify the condition of road pavement surface on the basis of characteristics of pothole namely depth, area and volume. Now a days in India there is no specific criteria for road maintains and road construction. Due to no specific criteria any representatives do unnecessary reconstructions or maintenance and vice versa. There is a need for a specific criterion for limiting the expenses made on this. There is need for developing such classification criteria for making choices regarding the maintenance of roads. In this project firstly we select the road and collected the information about there characteristics such as area, volume, depth and perimeter of pothole by using traditional methods but for area we use the android software in which by taking a photograph it will give us the area and perimeter of pothole. Then we have conducted a survey by using google form. In this survey there are many questions are asked for different ranges of pothole characteristics according to there impact on user. This questionnaire is send to total 35 experts. In which total 20 experts such as engineer, site engineers, road contractors & government contractors and remaining 15 are road users. According to there responses the reaction number is calculated for each pothole scale. By using this then the roads are priorities. according to the answers comes from calculation it is classified in different types such as Tolerable, Discomforting, Intense, Extreme, Very severe. Which will help for road maintains & road construction.

I. Introduction

Roads make important contribution to economic development and growth and bring important social benefits. They are of vital importance in order to make a nation grow and develop. In addition, providing access to employment, social, health and education services makes a road network crucial in fighting against poverty. Roads open up more areas and stimulate economic and social development. For those reasons, road infrastructure is the most important of all public assets.

A good transport system plays an important role for development of country. Such transport system consists of Asphalt, Concrete or combination of both in proportion. This system may have many defects such as potholes unevenness of manholes with road, skid resistance i.e. friction, improper drainage considerations and deflection. Pavement fail because of many factors, there are four primary reasons pavement fail prematurely. Failure in design, construction, materials and maintenance. There are different types of problems creating on existing road surfaces like as cracking, rutting, potholes and delimitation

The major impact of the maintenance will be in the form of area improvement, reduction in vehicle operating costs and travel time, performance of certain core sectors (cement, steel, construction equipment) and employment generation

The formation of potholes is degenerated by low temperatures, as water expands when it freezes to form ice, and puts greater stress on an already cracked pavement or road. Once a pothole forms, it grows through continued removal of broken chunks of pavement. If a pothole fills with water the growth may be accelerated, as the water "washes away" loose particles of road surface as vehicles pass. Potholes can grow to feet in width, though they usually only become a few inches deep, at most. If they become large enough, damage to tires and vehicle suspensions occurs. Serious road accidents can occur as a direct result, especially on motorways where vehicle speeds are greater. Potholes begin after snow or rain seeps into the soil below the road surface.

It is important to distinguished the types of potholes in order to choose the most suitable treatment and assign the appropriate property. Some jurisdiction classifies the potholes severity and assign priority levels based solely on their depth. Hence, we are dealing with potholes characteristics such as area, length, volume, depth. There are several reasons for potholes formation such as environmental, traffic loading and road pavement type and materials used for construction.

- Objective To study the pothole characteristics namely depth, area, volume and according
- to the characteristics of pothole to classify the road.
- To develop an index on the basis of pothole characteristics which will give guideline for maintenance and reconstruction of road.

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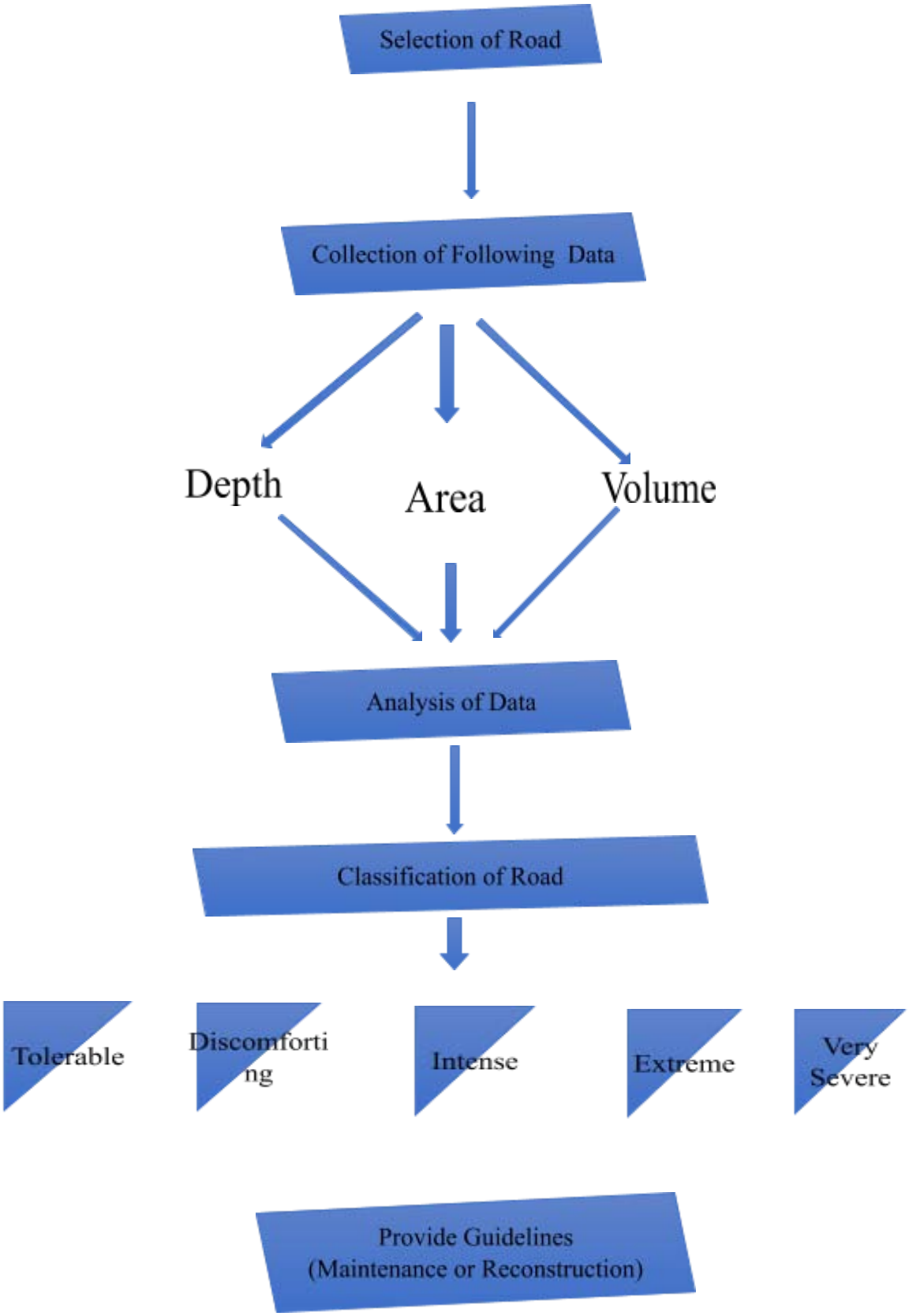
II. Methodology



Potholes have different properties such as its size, depth, area & volume. In this research we are going to analysis it's depth, area, volume and classify them according to collected information and use this for maintenances purpose or for reconstruction.

Firstly, we are going to find the depth of potholes. The method used for its calculation is taking a thread and scale for measuring depth, arrange the thread parallel to the road surface from one end of pothole to other end of pothole and tight the thread. Then put the scale perpendicular to the thread and note down the depth of it at different position. The position at which we get highest reading of depth is consider as the depth of that pothole.

Secondly, after this we are taking the measurement of volume of potholes. For this we are using two methods for small size potholes we are taking polythene and pouring water in it up to the surface level and taking this water in measuring cylinder to calculate volume of particular pothole, according to the depth of water in cylinder and area we have getting its volume.

Another method used for large size potholes. In this firstly are going to cover this pothole by cloth. And then pour the sand up to the road surface and remove this sand and place in container. Then by using volume container we will get the volume of large pothole.

For area, we are taking the photos of pothole at a fixed level and using android application known as "Sketch and Curves" we will get the accurate area of that pothole. Sketch And Calc™ is the application capable of calculating areas of uploaded images.

1. To calculate the area of a pothole, import the image from main menu in the top right corner, or paste an image saved in the clipboard.
2. Identify and draw the 'known length' using the rule tool from the toolbar.
3. Enter the known length and chosen measurement system, then submit with the tick.
4. With the scale now set, select 'add to canvas' to begin drawing your area.
5. After completing the drawing, we will get the perimeter of the draw area on field and its field area.
6. By taking the reference from various industry experts, engineers, professors we will assign a reaction number for the specific ranges of area & volume to decide the severity scale for the characteristics of various potholes and assessment of road condition. By combining the area and volume characteristics data to determine the severity index for road pavements.
7. After that we will classify the pothole severity and assign the priority levels which helps to analysis the pavement of existing roads on scale such as tolerable, discomforting, intense, extreme and very severe. Classification of characteristics of pothole and assign them the priority levels will serve as a selection factor for the maintenance and reconstruction of the pavement.

III. Analysis of Data

Case Study: 1
Place: Pune
Location: Kakade Chowk – Todkar Builders Site (VIIT College)
Description: Dense graded bituminous macadam (DBM)
Collection of data

Sr.no	Shape	Known Length (cm)	Depth (cm)	Area (cm sq.)	Volume (ccs)	Perimeter (cm)
1	Circle	29	3.5	1090.12	3000	125.02
2	Uncategorized	22	3.6	1749.59	3500	164.97
3	Mixed	42	6	2460	7800	310.09
4	Oval	19	2.5	367.28	600	77.24
5	Oval	31	7	5043.07	13100	317.14
6	Mixed	22	3.5	1277.6	1800	142.53
7	Oval	28.5	2.7	2169.14	2900	201.27
8	Circle	19	2.4	260.94	450	74.83
9	Uncategorized	46	4.2	2797.95	11500	198.99
10	Oval	37	4	1020.49	3600	126.07
11	Uncategorized	47	6.2	2784.43	7600	215.73
12	Mixed	66	5.4	2763.64	13500	221.18
13	Circle	26	3.5	693.15	1750	99.79
14	Oval	59	7.5	4607.82	13500	281.6

15	Circle	37	3.5	1429.01	1400	57.01
16	Oval	22.5	2.7	441.32	900	89.07
17	Uncategorized	29.5	3.2	143.07	3100	149.26

Case Study: 2
Place: Pune
Location: Kakade Chowk – Todkar Builders Site (VIIT College)
Description: Dense graded bituminous macadam (DBM)
Collection of Data

Sr. no	Shape	Known Length (cm)	Depth (cm)	Area (cm sq.)	Volume (ccs)	Perimeter (cm)
1	Circle	18	2.4	349.01	440	72.02
2	Oval	19	2.2	360.4	420	74.83
3	Uncategorized	18	2.3	960.01	1450	127.02
4	Mixed	24	2.4	1177.67	1700	153.33
5	Uncategorized	51	6.5	4103.10	7500	247.12
6	Uncategorized	18	2.3	340.11	460	69.02
7	Circle	19	2.2	355.02	420	79.05
8	Oval	22.6	1.8	401.22	510	89.02
9	Uncategorized	31	3.1	643.05	1100	99.17
10	Circle	15	2	290.30	350	57.90
11	Uncategorized	28	2.5	2049.03	4400	192.07
12	Mixed	29	2.4	346.20	660	73.40
13	Circle	20	2.2	366.20	540	76.03
14	Uncategorized	45	6.1	1963.02	8540	166.30
15	Oval	21.3	1.7	401.22	680	89.02
16	Mixed	22	3.6	693.13	1250	99.73
17	Oval	18	2.5	470	550	73.26
18	Circle	27	2.4	1943.40	4250	172.11

Case Study: 3
Place: Pune
Location: 36, Mukund nagar-11, Shankar Rao Lohane Marg
Description: Dense graded bituminous macadam (DBM)
Collection of data

Sr.no	Shape	Known Length (cm)	Depth (cm)	Area (cm sq.)	Volume (ccs)	Perimeter (cm)
1	Uncategorized	22.5	2.4	441.32	900	89.07
2	Uncategorized	25.5	3.1	973.07	3100	129.26
3	Circle	19	2.5	366.23	500	76.83
4	Oval	23.5	2.9	461.32	1000	97.07
5	Oval	57	5.0	1969.02	6900	260.9
6	Mixed	23.5	2.2	903.07	3200	126.27
7	Circle	19	2.4	365.23	450	75.83
8	Uncategorized	45	4.8	2477.08	6100	185.7
9	Uncategorized	29	2.4	643.06	1100	101.87
10	Mixed	33	3.6	1760.12	3600	166.97
11	Oval	16	2.1	270.26	400	270.26
12	Circle	33	2.1	1940.30	3800	179.01
13	Uncategorized	49	6.1	2784.43	8300	215.73

Case Study: 4
Place: Pune
Location: Punya Dham Ashram road- sunflower society
Description: Dense graded bituminous macadam (DBM)
Collection of data

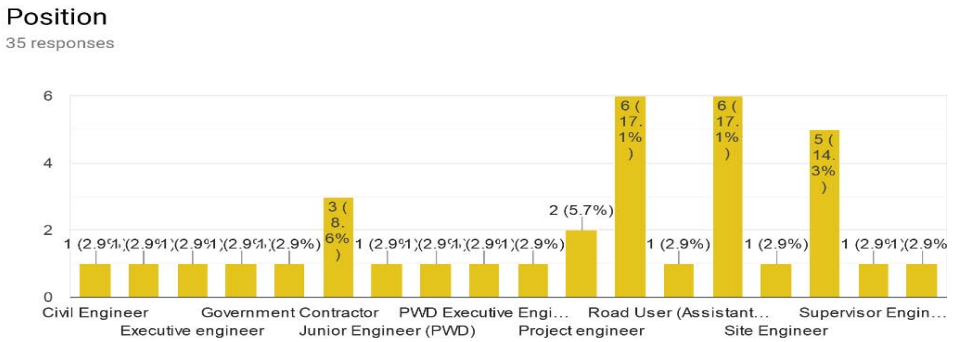
Sr.no	Shape	Known Length (cm)	Depth (cm)	Area (cm sq.)	Volume (ccs)	Perimeter (cm)
1	Uncategorized	39	3.9	1320.30	3900	145.71
2	Mixed	67	7.1	4560.5	11250	278.52
3	Oval	63	5.1	1970	6900	260.9
4	Uncategorized	32	6.5	1444.72	2200	269.52
5	Mixed	62	7.3	4607	8400	281.6
6	Uncategorized	35	6.2	1200.16	7200	269.25
7	Uncategorized	32	5.2	1515.20	5825	180.25
8	Oval	46	5.8	1600.40	6025	171.25
9	Mixed	42	4.6	1420.45	4700	150.81
10	Uncategorized	18	2.4	370.28	650	79.25
11	Mixed	22	2.5	395.26	690	88.67
12	Oval	36	3.6	1130.20	3200	131.07
13	Mixed	66	7.4	9125.55	12500	370.22
14	Mixed	58	6	2465	7500	320.09
15	Uncategorized	49	4.3	1530.52	5000	160.83
16	Circle	52	6.3	1895.81	5700	223.81
17	Mixed	43	5.9	1500	6246	178.25
18	Circle	67	7.8	4090.8	13500	279.54

Case Study: 5
Place: Pune
Location: Sai Sanskruti – Ultimate Power, KJEI Collage
Description: Dense graded bituminous macadam (DBM)
Collection of data

Sr.no	Shape	Known Length (cm)	Depth (cm)	Area (cm sq.)	Volume (ccs)	Perimeter (cm)
1	Oval	17	2.3	348.1	450	73.2
2	Mixed	20	2.1	365.2	430	72.85
3	Uncategorized	29.2	2.7	2048.5	2850	193.47
4	Circle	23.1	3.1	1265.8	1900	120.87
5	Oval	44.9	5.2	3005.45	6100	235.85
6	Uncategorized	39.5	6.9	2977.05	9000	280.5
7	Uncategorized	47	6.2	2784.45	8500	215.85
8	Oval	31.5	6.5	2501.45	6950	267.5
9	Mixed	21	1.8	380.25	410	89.25
10	Oval	41	4.5	1980.25	3100	192.91
11	Mixed	38	5.7	2835.85	6200	230.85
12	Oval	43	5.1	2939.05	5900	222.85
13	Uncategorized	28	3.5	1875.85	2500	181.81
14	Uncategorized	34.6	7.2	4875.25	12500	319.04
15	Uncategorized	55	4.9	2525.85	8200	122.25
16	Oval	42	5.4	2545.42	6000	198.05
17	Uncategorized	44.8	6.2	2585.25	8500	215.25
18	Oval	21	3.6	1575.5	2150	126.8
19	Uncategorized	39	7.3	5044.5	13100	175.8
20	Circle	22.1	3.2	1365.8	2100	140.35

21	uncategorized	40.5	6.5	3077.05	9120	290.6
22	Oval	40	4.7	2200	8000	111.25

Responses from questionnaire survey about reaction number



Calculations

$$X = \frac{N1R1+N2R2+N3R3+N4R4+N5R5+N6R6+N7R7+N8R8+N9R9}{\text{TOTAL LENGTH OF ROAD IN KM}}$$

N_1, N_2, N_3……. N_9 = Number of potholes for each range, R_1, R_2, R_3...R_9 = Reaction number for each range According to their responses we find out the reaction number as follows:

Area

Area ranges	Reaction number
0-1000 sq.cm	1.72
1000-2000 sq.cm	3.21
More than 2000 sq.cm	4.14

Depth

Depth ranges	Reaction number
0-2.5 cm	1.50
2.5-5.0 cm	2.98
More than 5.0 cm	4.23

Volume

Volume ranges	Reaction number
0-4000 cu cm	2.23
4000-8000 cu cm	3.64
More than 8000 cu cm	4.58

Results

From the questionnaire survey we get the reaction number

Area

Area ranges	Reaction number
0-1000 sq.cm	1.72
1000-2000 sq.cm	3.21
More than 2000 sq.cm	4.14

Depth

Depth ranges	Reaction number
0-2.5 cm	1.50
2.5-5.0 cm	2.98
More than 5.0 cm	4.23

Volume

Volume ranges	Reaction number
0-4000 cu cm	2.23
4000-8000 cu cm	3.64
More than 8000 cu cm	4.58

According to the calculation by the priority method the results for different roads are as follow:

For case study 1, X =157.61
For case study 2, X =125.15
For case study 3, X =95.48
For case study 4, X =187.39
For case study 5, X = 226.57

IV. Conclusion

From the survey and result, we got the reaction number for the different ranges of area, volume and depth & values for the priority of different roads mentioned in the case studies we have provided the different priority for roads

Priority order	Range of rating
Tolerable	0-50
Discomforting	50-100
Intense	100-150
Extreme	150-200
Very severe	Greater than 200

Form the above table conclude that

For Case Study 1: X=157.61, the above road is **Extreme** form the priority order.
For Case Study 2: X=125.15, the above road is **Intense** form the priority order.
For Case Study 3: X=95.48, the above road is **Discomforting** form the above order.
For Case Study 4: X=187.39, the above road is **Extreme** form the above order.
For Case Study 5: X=226.57, the above road is **Very Severe** form the order.

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Slope Walls Protection with the Artificial Grasshoppers Foot Method

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Abstract- The research objective is to provide an overview of the specifications, shape, dimensions, and configuration of the structure of the protective walls of the land with the method of the grasshopper and its of implementation in the field. This research method used the used research method and this study as well as a technical notes success story application of slope protective structures with artificial grasshopper foot method in the construction of flood control reservoirs in the city of Balikpapan. The results showed that the working of the installation of a slope protective wall structure with artificial grasshopper foot method could be applied and safely without incident. The stability of the slope retaining wall lies in the use of nail type foundations at the bottom, pairs of tread supporting walls, ground anchors, and drainage channels.

Keywords: slope protection walls, artificial grasshopper foot, three-point contact.

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I. Background

At the moment construction of a flood control reservoir is being carried out with a water holding capacity of 9,150 m 3 with a reservoir area of 3,650 m2 resulting in the formation of slopes on the three sides of the reservoir with slope heights of 12.5-14.5 meters, with slope angles of 55-65 degrees, where the toping is a residential area (Sulardi, Agus Sugianto, 2018). The problem faced is the problem of the difficulty of installing slope protective wall structures, because of the steep slope conditions and limited land conditions. The causes of the problem are pair factors, namely the steep slopes and the specifications of clay material in blackish gray and delicate texture that is fragile and becomes porridge if exposed to rainwater (Sulardi, Agus Sugianto, 2018). For these problems, control has also been carried out by covering the slopes with tarps to prevent softening and landslide of land by rainwater. On the upper side of the slope is scovered with a thin layer of lightweight concrete to prevent the permeation of rainwater, and manual inclinator installation is performed to monitor slope movement (Sulardi, 2016). However, this does not solve the problem because partially, there is still a collapse of slope land debris, so it is feare that mass slope failure will occur if slope protection is not carry out immediately.

With the background of these problems, this research is to do to overcome the problem to provide answers to research questions and find how to deal with these problems and safely. If this research is not carried out, the problem in the field will get worse, there will never be resolve, and the existing will also never find the answer. With this research, it is expectice that the problem can find with well, and the problems can be solved and safely.

The objectives expected to be achief through this research activity are (a) Provide a description of specifications, shapes, dimensions, and configuration of slope protective walls with the grasshopper feet method, and (b) Provide an overview of how to install slope protective walls with the grasshopper feet method. To achieve these objectives, further research questions were developed to be found through this research activity, namely (a) What is the description of specifications, shapes, dimensions and configuration of slope wall protection with artificial grasshopper foot method, and (b) How to carry out installation structure of slope wall with artificial grasshopper foot method.

The basic principle of protective slope structure with grasshopper foot method is to refer to the basic of balance on rock climbers or on grasshoppers who use both feet to rest and one hand to hold (three-point contact) so that their body weight can rest on vertical walls. The concept of a retaining wall using the artificial grasshopper foot method is a wall-mounted retaining wall made from reinforced concrete with ground anchor resistance at the top and in the contact area on the back side of the ground wall. This ground anchor pair serves to enlarge the resistance force (friction) on the ground wall so that it is safe against friction and lateral. This ground wall rests notch legs on size slopes that are installed every distance of 2 meters and installed zig-zag and so that it can suppress the shift of the ground wall towards the bottom. The gravity of the retaining wall is supported by the support of the drill pile foundation by reinforcing reinforced concrete wall fins.

II. Research Methods

a) Approach methods

This research is used research using the case study approach method, namely case studies overcoming the difficulties of installing a protective slope of land on a flood control reservoir. The forces acting on the soil wall are lateral forces due to the active soil pressure of the slope as high as 13 meters and the vertical force in the form of soil retaining wall and soil weight. The stability of the lateral force is obtained by the ground anchor strength (Hary Christady Hardiyatmo,

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2001). At the topping of the concrete retaining wall slab and the installation of ground anchor made of 19 mm diameter reinforcement with a distance of 1-meter installed with zig-zag 2 meter depth with bored and mortar injection to produce a large resistance force and able to withstand lateral forces due to active soil pressure (Robert W. Day, 2006). The stability of the retaining wall against this lateral force is enlarge with pairs of stiffened concrete columns mounted vertically on the walls of the concrete slab at a distance of 3 meters. The potential for additional active soil pressure due to the water content is reduce by installing drainage pipes on the concrete slab every 1-meter distance. Vertical force derived from the weight of the concrete slab of the soil wall itself (Suyono Sosrodarsono, Kazuto N, 1988) is reduce by supporting feet on the back of the retaining wall so that the vertical force forwarded to the foundation is relatively small. The vertical style residuals that are not reduced by notch feet are supported by a 60 meter diameter drill pile foundation with a depth of 10 meters with reinforcement of a 5 meter high concrete reinforced concrete wall size mounted on 4 wind directions so as to produce carrying capacity large and safe supporting the structure of the retaining wall safely. The behavior approach of the slope wall protection structure to do by structural analysis using the STAAT Pro. V. 8i program (Sulardi, Agus Sugianto, 2018).

b) Specifications of protective walls of artificial grasshopper slopes

The specification of slope protective wall material with the grasshopper foot method adopts the refractory mounting with the foot placemat and anchor shear connector (Sulardi, 2017) and installing truck bonded soil walls (Sulardi, 2016).

The material specifications of the ground protective wall with the method of artificial grasshopper feet are as follows :

a. Material specifications, reinforced concrete with concrete quality K-350
b. Concrete slab wall, bottom side width. 30 cm and the width of the upper side. 15 cm
c. Supporting tread, palm size. 45x60Cm, height 60 Cm, forms an angle of 90o to the slope and is fitted with a hose with a distance pole. 2 meters
d. Ground anchor, with the basic material of 19 mm diameter reinforcement and protected with a corrosion-resistant coating, the depth of entry into the minimum soil. 90 cm
e. Drainage pipe with thick layers of palm fiber. 5 cm
f. Upper stiffeners, concrete blocks 15x20 Cm, 2 meters long with a threaded reinforcement. 19 mm with 2 meters embedded depth
g. Formwork, thick multiplex. 14 mm with a laminate surface

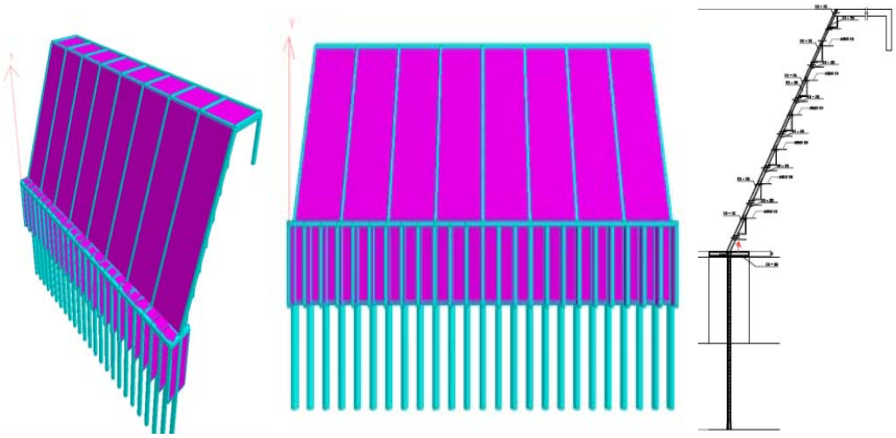

Figure 1: Slope wall protection with the artificial grasshoppers foot method

c) Equipment Used

a. Digging and soil work
b. Concrete work
c. Tools b, Pipe mounting
d. Tools c, Reinforcement and welding work
e. Equipment d, Scaffolding, stairs, and
f. Tools e, Other work
g. Support f, Personal protective equipment (PPE) and other work safety equipment
h. Other work aids according to the conditions at work

d) Installation Method

a. Install the supporting foundation of the slope protective structure with a drill pile foundation structure reinforced with several fins so that the drill pile foundation becomes rigid, sturdy and stable
b. Install the concrete slab capping on the slope protective structure, making sure the shape, dimensions, and configuration of the installation are in by the design
c. Install work tools to help to scaffoldfor work, material and work equipment

d. The shape of a support tread plate with shapes, dimensions, and configurations according to the design
e. Install a series of reinforcement bonding beams at the top of the slope with minimum ground anchor depth. 2 meters
f. Install a ground anchor with a threaded 19mm diameter material, insert it into the ground by pressing it to a minimum. 90cm by leaving the outside side as a binder of the wall reinforcement
g. Install the reinforcement wall of the slope by making sure the concrete decking has firmly installed and tie a reinforcement circuit with the ground anchor tip
h. Install drainage pipes, making sure the inside of the pipe has been wrapped in palm fiber
i. Install slope protective wall formwork, make sure the drainage pipes are place, and the formwork has firmly installed
j. Perform casting slope protective wall to a height of 120 cm and allow the concrete to harden well for 3x24 hours
k. After the concrete hardens, do the casting again on top by first saturating the concrete covering with clean water and anchoring with a bonding agent, this casting reaches a height of 30% of the total height of the protective slope concrete wall and let it harden well
l. After the concrete hardens, do the casting again on top by first saturating the concrete covering with clean water and anchoring with a bonding agent, this casting reaches a height of 50% of the total height of the protective slope concrete wall and let it harden well
m. After the concrete hardens well, do the casting again on top by first saturating the concrete toping with clean water and anchoring with a bonding agent, this casting reaches a height of 75% of the total height of the protective slope concrete wall and let it harden well
n. After the concrete hardens, do the casting again on top of it by first saturating the concrete covering with clean water and sprinkling the top with the bonding agent, casting it to reach the entire height of the protective slope, including the support beam at the top and let it hardens well
o. Perform hard treatment (curing) by covering the toping of the protective wall of the slope with a wet sack
p. Formwork can be remove if the concrete is 21 days old and has hardened completely, while still doing hard maintenance by moisturizing.

III. Results and Discussion

The structure of the sloping wall with the grasshopper foot method is the result of innovation by imitating the behavior of rock climbers and the behavior of the grasshoppers that can rest on the upright wall with three supports namely on both legs and one hand, or with two hands and one leg can move upward steady and safely. The protective slab concrete slab wall has a wall supporting foot size of 45x60x60 Cm resembling a console every 2 meters apart which is installed alternately so that the wall load is flat. As a binder, ground anchors are used based on a screw diameter of 19 mm in diameter and are cooked into the ground by drilling and pressing. This ground anchor drill hole is first injection with concrete mortar as a bond. After hardening the ground anchor, it will function as an anchoring system in general. To repair between the inside of the protective wall of the soil and the slope of the soil surface, the surface of the targeted by notch so that the surface forms cracks when concrete mortar casting is carried out, the fillings will be filled with concrete mortar.

The results showed a 50 Cm diameter bored pile model with reinforced concrete fill material with FC.29,7 concrete quality, 5 meter drill mast depth, then at 5 meters above it consisted of a drill pole reinforced with 5 meter high concrete wall fins on the north, south, east and west with a fin length of 1.5 meters and after reinforced concrete fins are installed and filled with soil with brownish red sandy clay proven to support a 14 meter sloping wall slope angle of 65 degree. Based on the stress contour that works due to the combination load on the slope wall slab, the maximum stress that occurs is 17.6794 N / mm^2 $<\sigma$ permits are 289.2962 N / mm^2 (0.85 FC), within safe limits whereas the amount of deflection in the concrete retaining wall slab that occurs at the beam is -3.156 mm $<$10 mm (1/200 L), within the safe limit. The foundation of the drill poles with stiffening fins is the development of tack foundation as a result of the improvement of researchers who have won the Gold Medal in the CIP program of PT. Pertamina and its status are currently in the progress of proposing patent rights at Kemenkumham with No. Registration P00201700891, dated February 08, 2017. The method of installation of slope structures with the grasshopper leg proved to be well applied and from work safety aspects during foundation work and installation of slope protective walls with the grasshopper foot method has donated 1,800 safe working hours (zero incident) without an accident.

The application of structural stability with the three-point contact principle on the protective wall is on pairs of footstools above the excavation sites which make the structure of the slope protective wall resting well on the slope so that it becomes an inseparable part and can protect the soil from the effect of rainwater runoff so that it can prevent slope landslides. The sites on the slope surface will function as a substitute for the practice foundation, and the ground anchor will be a substitute for the nature of the grass roots which can tie the aggregate to the slope so that it blends well. The

roughness of the soil surface, which is then covered by concrete mortar will be a substitute for hair roots in grass plants which enlarges the bond between the soil and the slope-protective structure. The drainage pipes on the protective slope concrete wall will drain the water trapping in the ground slope so that it can reduce and suppress as little as possible the influence of water weight on the soil wall and the presence behind the soil wall, while a water that is not drained out will function the soil remains moist under conditions of maximum plasticity.

IV. Conclusion AND Suggestions

a) Conclusions

From the research activities that have been carried out, the following can be take:

1. Specifications of slope protective wall structure with grasshopper foot method is reinforced concrete slope protective wall equipped with the ground anchor at the top and on a concrete slab with 19 mm threaded diameter reinforcement armature material 2 meters deep, equipped with supporting footprints inside and drainage channels to remove water content in the slope.
2. The method of installing retaining walls is a method of artificial grasshopper feet by installing pedestal foundations, installing capping beams, installing anchor toppings, installing placards and ground anchor walls, installing drainage channels, installing reinforcements and formwork and casting using FC. 29,7 concrete quality mortar.

b) Suggestions

The following are some suggestions that can be given for further research
related to the use of slope protective structures with the grasshopper foot method as follows:

1. The research is needed to make the protective wall of the slope of the grasshopper foot method with precast concrete slab by first installing a ground anchor to fasten the precast concrete slab
2. It is necessary to develop segmental protective slope structure methods to install precast retaining wall concrete slabs on ground anchoring so that the installation is faster and more practical.

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Reactions of Hydrated Lime-Saw Dust Ash Blend on the Strength Properties of cement Concrete

By Awodiji T.G. Chioma, Dimo J. Onyebuchi, Nwurumibe Chukwebuka, Awodiji O. Olujide & Arimanwa I. Joan

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Abstract- This study was carried out to determine the reaction of Hydrated lime (HL)-Saw dust ash (SDA) blend on the strength properties of cement concrete. Compressive strength and modulus of elasticity with respect to water-cement ratio and percentage replacements of Portland cement (PC) were experimented. Concrete was prepared using a constant mix ratio of 1:2:4 with varying water-cement (w/c) ratios of 0.55, 0.57, 0.58, 0.6, and 0.65respectively. Percentage replacements of port land cement with HL and SDA of 0%, 10%, 20% and 30% for HL-SDA proportions of 50%:50% and 75%:25% respectively were investigated. Portland cement, river sand, granite chippings, hydrated lime and saw dust ash were the materials used. 150mmx150mmx150mm concrete cube sizes, were adopted as specimen. The concrete were kept damp in open water tanks at room temperature and then tested in compression after 28days and 56days.

Keywords: hydrated lime (HL), saw dust-ash (SDA), water-cement (W/C) ratio, portland cement (PC), compressive strength, modulus of elasticity.

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Keywords: hydrated lime (HL), saw dust-ash (SDA), water-cement (W/C) ratio, portland cement (PC), compressive strength, modulus of elasticity.

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I. Introduction

The use of concrete as a construction material has over the years, gained wide acceptance globally. This is why the need to come up with concrete with distinct and useful features e.g. improved durability and strength has always been a welcomed idea. According to [1], the current production of cement, which is a major component of concrete is growing by 2.5% annually, and is anticipated to rise from 2.55 billion tons in 2006 to 4.4 billion tons by 2050. Regrettably, cement production is judged to be one of the major giver of the heat wave gas emissions into the atmosphere. It entails the substantial discharge of carbon dioxide from the chemical processes involved. Present-day evaluations are that this process contributes about 5% of total human induced CO_2 emissions excluding land use change [2]. An additional process that could put in a further 60% to the operation is the firing of fossil fuel to bring on the relevant energy requirement for heating up the raw materials at temperature well over 1000^{0}C [3].According to [4], total emissions from the cement industry contribute as much as 8% of world-wide CO_2 release. This gas has evolved to the various ruinous climatic conditions wrecking the earth today. So, alternative cement that is more sustainable as well as cost effective are being suggested by sundry researches in the field of concrete technology, in order to minimize the cement industry's contribution to these problems and make cement production more energy efficient.

Reducing emission from the incinerating exercise means looking for a material other than limestone. Combined cement replaces some of the limestone-based clinker with other materials such as fly-ash, silica fume and agricultural waste products that are pozollanic in nature. These blends also assist in reducing the energy demand for the calcination process thereby making the procedure more energy friendly. In

this innovative examination, a blend of hydrated lime and saw dust ash as incomplete substitutes for cement in making concrete was appraised. Special attention was given to the effects of water cement ratio and percentage replacement of portland cement with HL and SDA on the compressive strength and modulus of elasticity of the concrete. [5] defined *hydrated lime as a dry white powder consisting essentially of calcium hydroxide obtained by treating lime with water. It is traditionally called slaked lime*. It has many names including builder's lime, pickling lime, cal and slaked lime. It has many uses that comprises: a flocculant, in water and sewage treatment and improvement of acid soil; an ingredient in whitewash, mortar and plaster; an ingredient in baby milk; a home remedy for throat infections as well as sprains and a chemical reagent. In combination of water, sand or cement, it is used to make mortars and plasters.

Saw dust is wood biomass occasioned by the timber industry. It is a notable waste and is usually used as a wood fuel for generating energy. The burning of saw dust reduces its size and gives rise to a product known as saw dust ash (SDA)[6]. Most times, this ash is not capably gotten rid of but is openly left on dump sites. Accordingly, it creates health and environmental challenges. The inhalation of saw dust ash or saw dust into the body can lead to breathing complications like asthma or lung cancer. When in contact with the skin, SDA can result to irritation or ulceration of the skin[7]. One manageable way of doing away with this waste is by integrating it as a part of the materials in the making of concrete.

Works on concrete and mortar incorporated with SDA and HL have been performed by many authors. [8]used SDA having 45% hydrated lime as partial replacement of ordinary portland cement (OPC) for making hollow blocks, in order to solve the issues of environmental and economic consideration. Their results showed at 10% OPC replacement with SDA, a cement to aggregate mix of 1:8at 0.55 w/c ratio, produced the highest compressive strength. They also suggested that the cement-aggregate mix could be reduced to achieve higher strength. [9] studied some properties of concrete made using hydrated lime and pozzolans (silica fume, fly ash and metakaolin) as substitutes for portland cement. Results from this studies revealed that structural concrete could be produced from silica fume-lime mixes and silica fume-fly ash-lime mixes. They concluded that metakaolin-lime mix could only be used for making mortar. The pozzolanic-lime mixes showed longer setting time and lower heat of hydration than the PC mix. This is an advantage during hot weather concreting.

[10] worked on the environmental credentials of hydraulic lime-pozzolan concret. They perceivedthat using hydraulic lime (NHL5) alone as a green alternative binder to portland cement (CEM 1) is not practical. But, the use of NHL5 with pozollanic materials, showed a more applicable low-carbon substitute to CEM 1 and CEM 111A in defined conditions.[11] analyzed the partial replacement of cement with SDA in concrete and reported that its advantage can only be derived when PC is replaced with SDA at a level not exceeding 10%. Maximum benefits was seen to occur at 5% substitution. An increase in strength was detected at longer curing age. But, it reduced as the percentage of SDA increased. Further, they perceived that the concrete became more workable as the proportion of SDA increased.

Similarly,[12] worked on SDA as partial replacement of cement. He uncovered that the inclusion of SDA in cement promoted the occurrence of little expansion due to low carbon content. In addition, he observed that the early strength gain was about 50% to 60% of the 28th day strength. Furthermore, he recommended amaximum percentage replacement of PC with SDA of 10% by volume in all grades of cement studied. [13] stated that wood waste, either in the form of saw dust ash or wood aggregate can be included into the concrete mix to form structural concrete. This concrete is seen to have good durability properties as the percentage water absorptions reviewed were less than 10% [14]. They expressed that the replacement level must not be greater than 20%. [15], from their studies observed that the compressive strength of concrete decreased with increase in SDA. They recommended a 5% optimal OPC replacement with SDA.[16] worked on the properties of concrete modified with low density polyethylene (LDPE) and saw dust ash. From their findings, they stated that the workability of the concrete decreased as percentage replacement of LDPE and saw dust ash increased. Also, the strength properties of the modified concrete reduced when compared to the conventional mix. In addition, density of the modified mix was less than that of the conventional mix. Finally, they recommended an optimal combination of LDPE and saw dust of 5% and 3% respectively.

II. Experimental Works

a) Materials

In this investigation, the material used for making concrete in the laboratory include; portland cement, hydrated lime, saw dust ash, river sand, granite chippings and water. The grade 42.5R portland cement with brand name "Dangote" was used and produced according to [17]. This was bought from Naze market in Owerri-west Local Government Area of Imo state, Nigeria. Hydrated lime was obtained from Eiestening Calcining Company in Okene, Edo State. Its physio-chemical properties are presented in Table 1.Saw dust was procured from the Naze wood market. It was air dried for 3 days and then heated (while stirring) in an

open pot until it was observed that there was no more release of steam. This was done to reduce to minimum its moisture content. The saw dust was then calcined by open air burning. The ash obtained was further pulverised using a grinding mill and sieved with a 75 micro sieve for efficient mixing with hydrated lime and portland cement. Physio-chemical test result of the saw dust ash is presented on Table 2.

Fine aggregate of nominal size 5mm, obtained from Otamiri River in Owerri-West, was used. This aggregate was washed thoroughly and sun dried for a week, before being used. Also, granite chippings of nominal size 19mm was obtained from the quarry site of Arab contractors Nigeria Limited Owerri, Imo State. The aggregates were properly sieved using a mechanical sieve shakers in accordance with [18]. River sand and granite chippings were observed to be poorly graded and had bulk density values of 1657.30kg/m^3 and 1571.65kg/m^3 respectively. The water used for this research work was portable and obtained from the Federal University of Technology, Owerri.

Table 1: Physio-chemical properties of the hydrated lime (HL)

Component	Percentage (%) composition
CaO	82
MgO	5.3
H_20	0.87
$Ca(OH)_2$	86.47
SiO_2	2.54
PH	9.03
Al_2O_3	4.85
Others	3.52
Loss of ignition	0.23
Property	**Description**
Colour	White
Solubility	Partially soluble in H_2O and HCl
Texture	Smooth

Plate 1: Hydrated lime

Table 2: Physiochemical properties of sawdust ash (SDA)

Component	Percentage (%) composition
K_2O	1.77
Na_2O	2.76
Fe_2O_3	2.41
SiO_2	65.3
Al_2O_3	4.25
MgO	5.32
CaO	9.98
Loss of ignition	3.95
Specific gravity	2.33
Mean particle size	179 μm
Bulk density	760kg/m^3

Plate 2: Saw dust ash

b) Methods

A total of 350 mix proportion were investigated. A mix ratio of 1:2:4 (binder: fine aggregate: coarse aggregate) at varying water-cement ratio of 0.55, 0.57, 0.58, 0.60and 0.65 was adopted. Percentage replacement of PC with SDA of 0%, 10%, 20% and 30% were experimented. For each percentage replacement considered, the effect of PC to SDA proportion of 75%: 25% and 50%: 50% were studied. Batching of the material was done by weight using a weighing balance of 50kg capacity. The sand was measured and mixed thoroughly with the cement, hydrated lime, and saw dust ash in a waterproof surface before the granite chippings was added. Water was then included and the whole batch was uniformly mixed using a shovel. Table 3 to Table 6 shows the mix proportioning of materials.

The material was poured into oil coated, metal square molds of cross section 150mm x 150mm. These molds were kept on clean, level and firm surface. The concrete in the mold was compacted in 3 layers with each layer receiving 25 blows of a 25mm steel rod. The surface of the mold was levelled and marked for identification. The specimen were left to set and the molds removed after 24 hours. They were then placed in water tanks at room temperature and left to cure for 28days and 56 days respectively.

Table 3: Mix proportion of concrete cubes with 10% replacement of Portland cement with hydrated lime and saw-dust ash

Mix Ratio							Mix proportion in weight for 1 cube (kg)					
MIX NO	W/C	PC	HL	SDA	Sand	Granite	Water	PC	HL	SDA	Sand	Granite
A_1	0.55	0.90	0.05	0.05	2	4	0.707	1.157	0.064	0.064	2.571	5.143
A_2	0.57	0.90	0.05	0.05	2	4	0.733	1.157	0.064	0.064	2.571	5.143
A_3	0.58	0.90	0.05	0.05	2	4	0.746	1.157	0.064	0.064	2.571	5.143
A_4	0.60	0.90	0.05	0.05	2	4	0.772	1.157	0.064	0.064	2.571	5.143
A_5	0.65	0.90	0.05	0.05	2	4	0.836	1.157	0.064	0.064	2.571	5.143
A_6	0.55	0.90	0.75	0.25	2	4	0.707	1.157	0.096	0.032	2.571	5.143
A_7	0.57	0.90	0.75	0.25	2	4	0.733	1.157	0.096	0.032	2.571	5.143
A_8	0.58	0.90	0.75	0.25	2	4	0.746	1.157	0.096	0.032	2.571	5.143
A_9	0.60	0.90	0.75	0.25	2	4	0.772	1.157	0.096	0.032	2.571	5.143
A_{10}	0.65	0.90	0.75	0.25	2	4	0.836	1.157	0.096	0.032	2.571	5.143

Table 4: Mix proportion of concrete cubes with 20% replacement of Portland cement with hydrated lime and saw-dust ash

Mix Ratio							Mix proportion in weight for 1 cube (kg)					
MIX NO.	W/C	PC	HL	SDA	Sand	Granite.	Water	PC	HL	SDA	Sand	Granite
B_1	0.55	0.80	0.10	0.10	2	4	0.707	1.029	0.129	0.129	2.571	5.143
B_2	0.57	0.80	0.10	0.10	2	4	0.733	1.029	0.129	0.129	2.571	5.143
B_3	0.58	0.80	0.10	0.10	2	4	0.746	1.029	0.129	0.129	2.571	5.143
B_4	0.60	0.80	0.10	0.10	2	4	0.772	1.029	0.129	0.129	2.571	5.143

B_5	0.65	0.80	0.10	0.10	2	4	0.836	1.029	0.129	0.129	2.571	5.143
B_6	0.55	0.80	0.15	0.05	2	4	0.707	1.029	0.193	0.064	2.571	5.143
B_7	0.57	0.80	0.15	0.05	2	4	0.733	1.029	0.193	0.064	2.571	5.143
B_8	0.58	0.80	0.15	0.05	2	4	0.746	1.029	0.193	0.064	2.571	5.143
B_9	0.60	0.80	0.15	0.05	2	4	0.772	1.029	0.193	0.064	2.571	5.143
B_{10}	0.65	0.80	0.15	0.05	2	4	0.836	1.029	0.193	0.064	2.571	5.143

Table 5: Mix proportion of concrete cubes with 30% replacement of Portland cement with hydrated lime and saw dust ash

Mix Ratio							Mix proportion in weight for 1 cube (kg)					
MIX NO	W/C	PC	HL	SDA	Sand	Granite	Water	PC	HL	SDA	Sand	Granite
C_1	0.55	0.70	0.15	0.15	2	4	0.707	0.90	0.193	0.193	2.571	5.143
C_2	0.57	0.70	0.15	0.15	2	4	0.733	0.90	0.193	0.193	2.571	5.143
C_3	0.58	0.70	0.15	0.15	2	4	0.746	0.90	0.193	0.193	2.571	5.143
C_4	0.60	0.70	0.15	0.15	2	4	0.772	0.90	0.193	0.193	2.571	5.143
C_5	0.65	0.70	0.15	0.15	2	4	0.836	0.90	0.193	0.193	2.571	5.143
C_6	0.55	0.70	0.225	0.075	2	4	0.707	0.90	0.289	0.032	2.571	5.143
C_7	0.57	0.70	0.225	0.075	2	4	0.733	0.90	0.289	0.096	2.571	5.143
C_8	0.58	0.70	0.225	0.075	2	4	0.746	0.90	0.289	0.096	2.571	5.143
C_9	0.60	0.70	0.225	0.075	2	4	0.772	0.90	0.289	0.096	2.571	5.143
C_{10}	0.65	0.70	0.225	0.075	2	4	0.836	0.90	0.289	0.096	2.571	5.143

Table 6: Mix proportion of concrete cubes with 0% replacement of Portland cement with hydrated lime and saw-dust ash

Mix Ratio					Mix proportion in weight for 1 cube (kg)			
MIX NO	W/C	PC	Sand	Granite	Water	Cement	Sand	Granite
D_1	0.55	1	2	4	0.707	1.286	2.571	5.143
D_2	0.57	1	2	4	0.733	1.286	2.571	5.143
D_3	0.58	1	2	4	0.746	1.286	2.571	5.143
D_4	0.60	1	2	4	0.772	1.286	2.571	5.143
D_5	0.65	1	2	4	0.836	1.286	2.571	5.143

Plate 3: Concrete cubes

Compressive strength test on hardened hydrated lime-saw dust ash-cement concrete according to [19] was carried out and the equation 1 was used to achieve the compressive strength values.

$$\text{Compressive Strength (N/mm}^2\text{)} = F/A \quad (1)$$

Where F = Applied force by the compression testing machine (KN) and A = Cross sectional area of the cube (m^2). Results obtained from this test are presented on Table 7. In addition, the modulus of elasticity was determine from the values of the compressive strengths of the concrete according to [20] for normal density concrete using the equation 2:

$$Ec = 4700\sqrt{Fc} \quad (2)$$

Where *Fc* = Compressive strength (N/mm^2). The results obtained are also presented in Table 7

III. Results and Discussion

The results obtained after the investigation on compressive strength and modulus of elasticity of the HL-SDA cement concrete are as shown in Table 7.

Table 7: Results of strength tests carried out on the HL-SDA- cement concrete

MIX PLAN	HL:SDA	Mix no.	28 DAYS COMPRESSIVE STRENGTH (N/mm^2)	56 DAYS COMPRESSIVE STRENGTH (N/mm^2)	28 MODULUS OF ELASTICITY (N/mm^2)	56 DAYS MODULUS OF ELASTICITY (N/mm^2)
HL-SDA 10%	50%:50%	A_1	21.33	24.44	21706.67	23235.31
		A_2	24.44	25.24	23235.31	23612.53
		A_3	22.67	22.67	22378.12	22378.12
		A_4	21.42	22.22	21752.42	22154.90
		A_5	18.67	19.77	20308.13	20897.83
	75%:25%	A_6	23.02	24.00	22550.21	23025.20
		A_7	24.44	25.69	23235.31	23822.09
		A_8	27.56	30.40	24673.88	25914.01
		A_9	27.11	27.64	24471.61	24709.67
		A_{10}	23.56	25.78	22813.16	23863.78
HL-SDA 20%	50%:50%	B_1	16.89	23.11	19315.80	22594.24
		B_2	17.96	24.00	19918.24	23025.20
		B_3	21.33	26.22	21706.67	24066.57
		B_4	22.49	22.58	22289.10	22333.66
	75%:25%	B_5	17.78	20.67	19818.18	21368.21
		B_6	22.58	21.78	22333.66	21934.45
		B_7	23.11	25.33	22594.24	23654.59
		B_8	22.67	25.44	22378.12	23705.90
		B_9	21.33	27.11	21706.67	24471.61
		B_{10}	21.33	26.44	21706.67	24167.33
HL-SDA 30%	50%:50%	C_1	19.11	21.33	20546.04	21706.67
		C_2	18.67	22.67	20308.13	22378.12
		C_3	18.72	21.89	20335.31	21989.77
		C_4	18.89	21.78	20427.43	21934.45
	75%:25%	C_5	17.86	19.91	19862.71	20971.69
		C_6	17.78	21.33	19818.18	21706.67
		C_7	18.67	21.78	20308.18	21934.45
		C_8	20.00	24.00	21019.04	23025.20
		C_9	17.78	18.67	19818.18	20308.13
		C_{10}	16.71	18.13	19212.60	20012.29
		D_1	23.11	23.11	22594.24	22594.24
HL-SDA 0%		D_2	24.44	25.02	23235.30	23509.40
		D_3	23.56	24.44	22813.16	23235.30
		D_4	22.22	23.56	22154.90	22813.16
		D_5	18.13	19.11	20012.29	20546.04

a) Effect of percentage replacement of PC with HL and SDA on the concrete

A close review of the results shown in Table 7 revealed that in general, mix ratios having a proportion of 75%HL:25%SDA gave higher strength values than those with 50%HL:50%SDA. As the curing age increased, compressive strength of the concrete increased as well. Highest compressive strength was obtained at 10% replacement of PC with HL and SDA. A value of 30.40N/mm^2at 56 days was reached at a water-

cement ratio of 0.58, having75% HL: 25%SDA. Comparing this value with that of the control mix, a rise in strength of 17.70% was achieved. Highest 28 days strength obtained was 27.56N/mm^2. Therefore, an increase in strength of about 10.31% was observed from 28 days to 56 days of curing. The mixes having 10% replacement of PC were observed to produce structural concrete. Except for mix A_5 which had a 50% HL: 50%SDA proportion at water-cement ratio of 0.65. This may be due to the fact that the water content in the concrete was too high and so, strength dropped. The strength of concrete with 75%HL: 25%SDA at 56 days, were higher than those of the control values.

A reduction in strength was generally observed for the 20% and 30% replacement of PC with HL and SDA. But, at 20% replacement, 56 days of curing and 50%HL: 50%SDA, an increase in strength of 15.66%, 1.62% and 4.555% were observed at water-cement ratios of 0.58, 0.6 and 0.65 respectively, when compared to the 10% replacement. The highest compressive strengths reached at 28 days and 56 days were 23.11N/mm^2 and 27.11N/mm^{2}at mix nos. B_7 and B_9 respectively. 20% replacement of PC with HL and SDA still resulted to the production of structural concrete except for mix nos. B_1, B_2 and B_5 at 28 days.

At 30% replacement, it was generally observed that the 56 days, 50%HL: 50%SDA proportion generated slightly higher strength values than the 75%:25% proportions. Although, the optimal strengths of 20N/mm^2 and 24N/mm^2 at 28 days and 56 days respectively, were recorded by the 75%HL:25%SDA. Since hydrated lime is known to improve workability in fresh concrete, a 50% content of SDA in the mixture will absorb more water than a 25% SDA content. This resulted to less water in the 50%HL:50%SDA and more in the 75%HL:25%SDA. With lesser water content in the concrete, strength increased slightly.

At 10% replacement of PC with 75%HL: 25%SDA, optimum values of modulus of elasticity were recorded at 0.58 w/c ratio. These highest values were 24,673.88N/mm^2 at 28 days and 25,914.01N/mm^2 at 56 days. These were higher than the control values, showing that the inclusion of HL and SDA in the proportion of 75%:25% resulted to a stiffer concrete. This concrete will experience a reduction in deflection when compared to the conventional one. On the other hand, highest values of modulus of elasticity for the 50%HL:50%SDA inclusion occurred at a w/c of 0.57. These values were 23,235.31N/mm^2 and 23,612.53N/mm^2 for the 28 days and 56 days respectively. It was generally observed that the addition of 50%HL: 50%SDA, did not improve the modulus of elasticity of concrete.

20% inclusion of HL and SDA generally reduced the values of the modulus of elasticity of the concrete when compared to the 10% inclusion. Highest value of 24, 471.61N/mm^2 was achieved at 0.6 w/c ratio for the 56 days having 75%HL: 25%SDA mixture. Overview, the control readings were higher than those obtained from the 28 days specimen. Only the concrete produced from the 75% HL and 25%SDA at w/c between 0.6 and 0.65, experienced an improvement of modulus of elasticity.

The results of modulus of elasticity from the 30% inclusion of HL and SDA gave values that were lower than those obtained from the control mixes. This means that a 30% replacement of PC with HL and SDA will reduce the stiffness of the concrete.

b) Effect of water cement ratio on the strength properties of HL-SDA cement concrete.

Fig 1 to Fig 4 present the relationship between the compressive strength of HL-SDA cement concrete and water cement ratio.

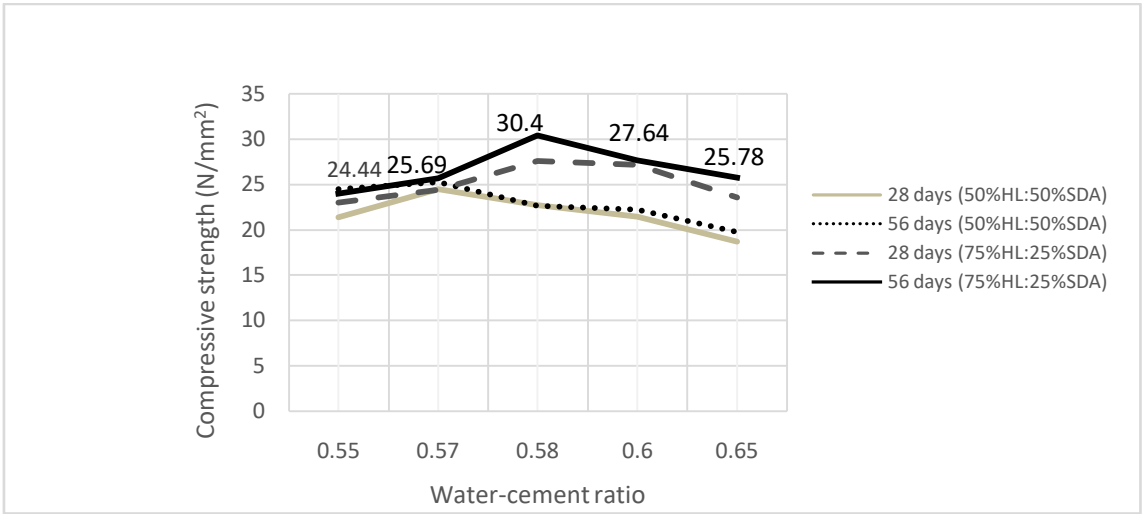

Fig. 1: Relationship between compressive strength of HL-SDA cement concrete with 10% PC replacement and water-cement ratio.

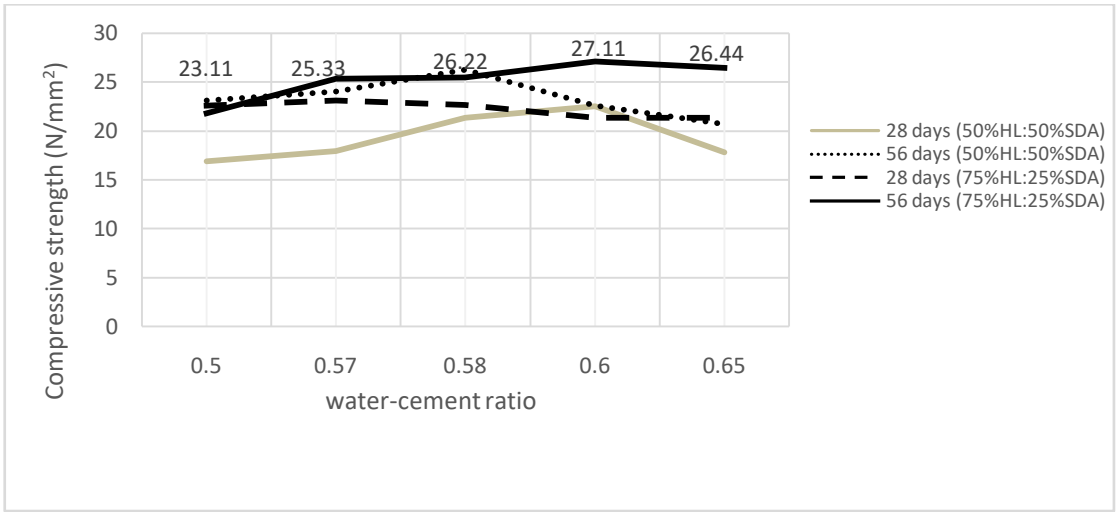

Fig. 2: Relationship between the compressive strength of HL-SDA cement concrete with 20% PC replacement and water-cement ratio.

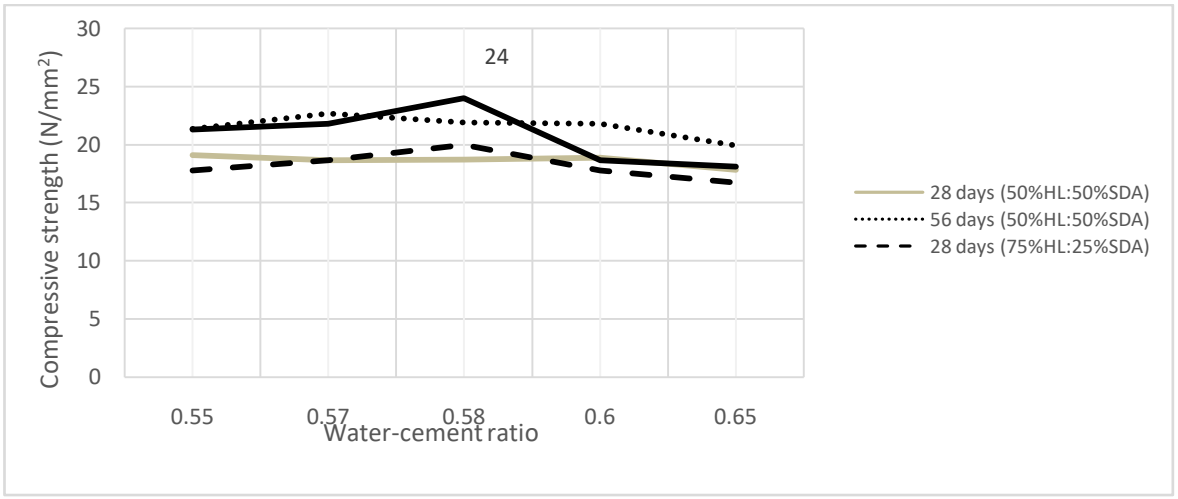

Fig. 3: Relationship between the compressive strength of HL-SDA cement concrete with 30% PC replacement and water-cement ratio.

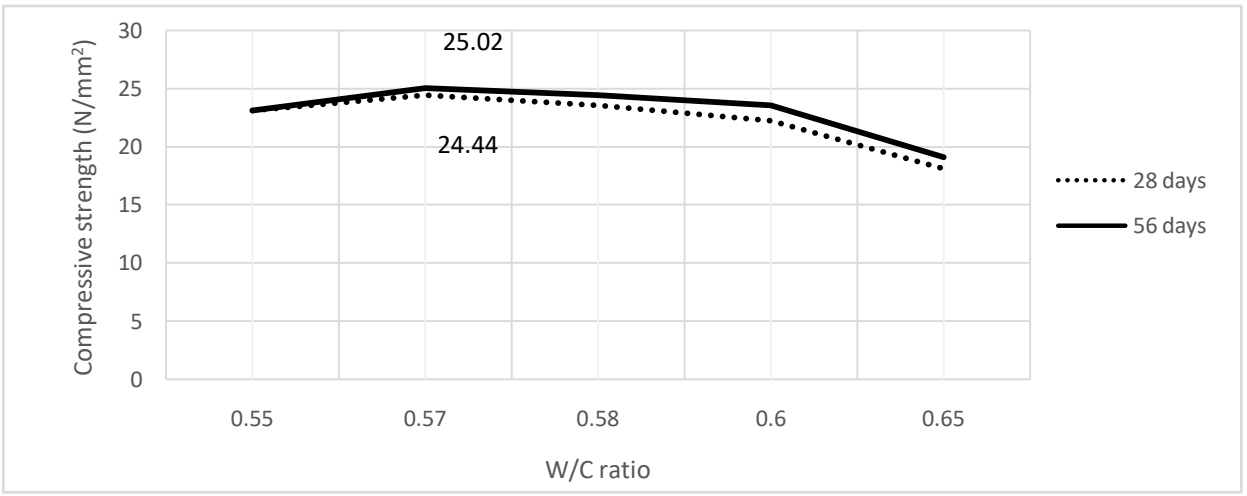

Fig. 4: Relationship between the compressive strength of cement concrete and water-cement ratio.

In general, it can be seen that the compressive strengths of the concrete increased to optimum water-cement ratios, before they began to drop. At 10% replacement of PC with HL and SDA, compressive strength for the 50%HL: 50%SDA increased until an optimum water-cement ratio of 0.57 was achieved. Thereafter, strength reduced. For 75%HL: 25%SDA, optimum water cement ratio happened at 0.58. These were observed for the two curing ages. At a water-cement ratio of 0.55, the concrete mix having 50%HL: 50%SDAat 56 days, experienced the highest strength value.

Considering the 20% replacement (50%HL: 50%SDA), the water-cement ratio that generated the greatest strength was 0.6 at 28 days and 0.58 at 56 days. For 75%HL: 25%SDA, highest strength occurred at water-cement ratio of 0.60. At 30% PC substitution with HL and SDA, highest strength also occurred at 0.58 water-cement ratio. The effects of w/c ratio on the modulus of elasticity of the concrete is illustrated in Fig 5 to Fig 7.

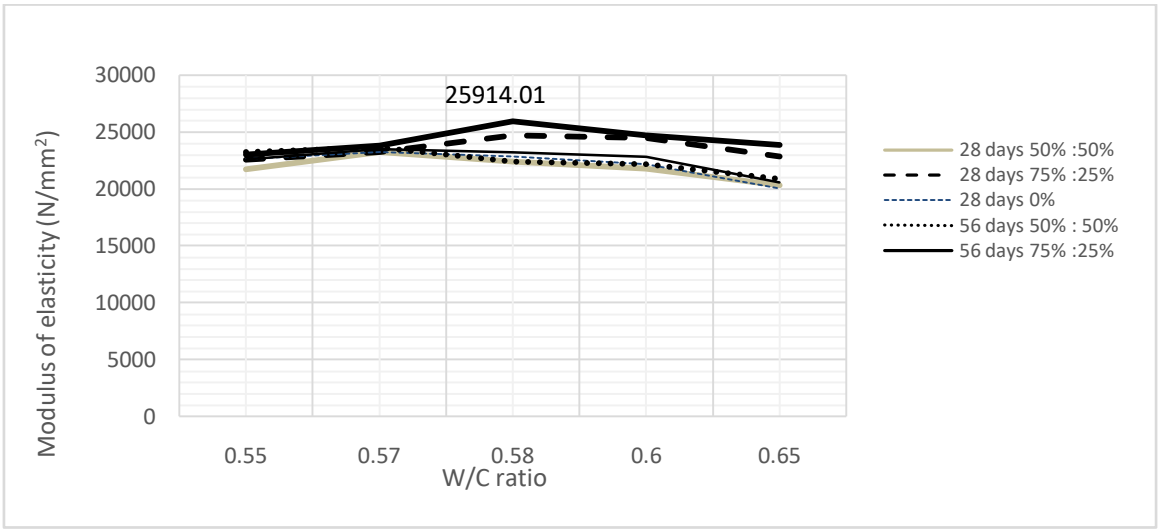

Fig. 5: Effect of water-cement ratio on the modulus of elasticity of HL-SDA cement concrete with 10% and 0% PC replacement.

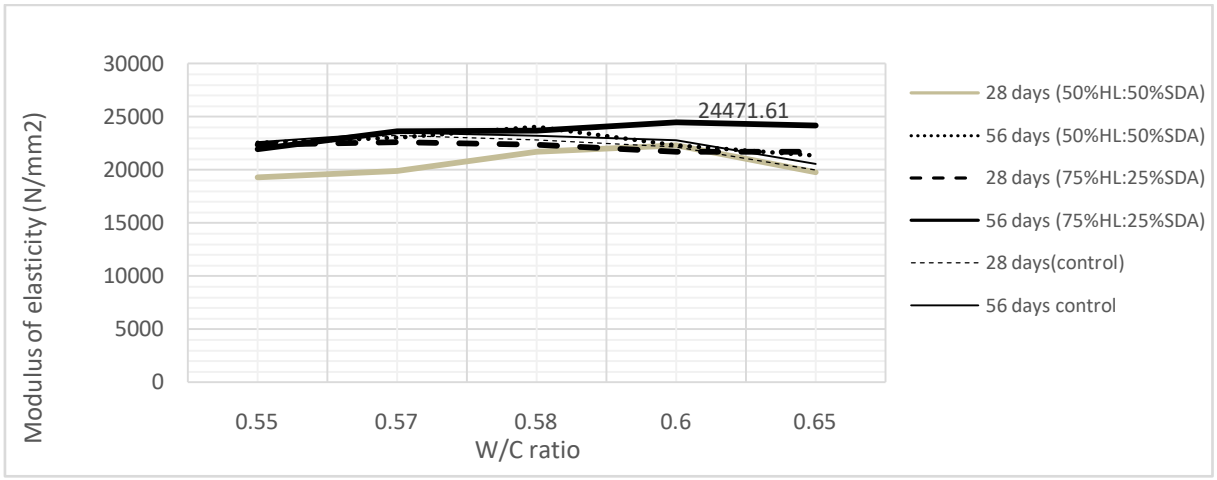

Fig. 6: Effect of water-cement ratio on the modulus of elasticity of HL-SDA cement concrete with 20% and 0% PC replacement.

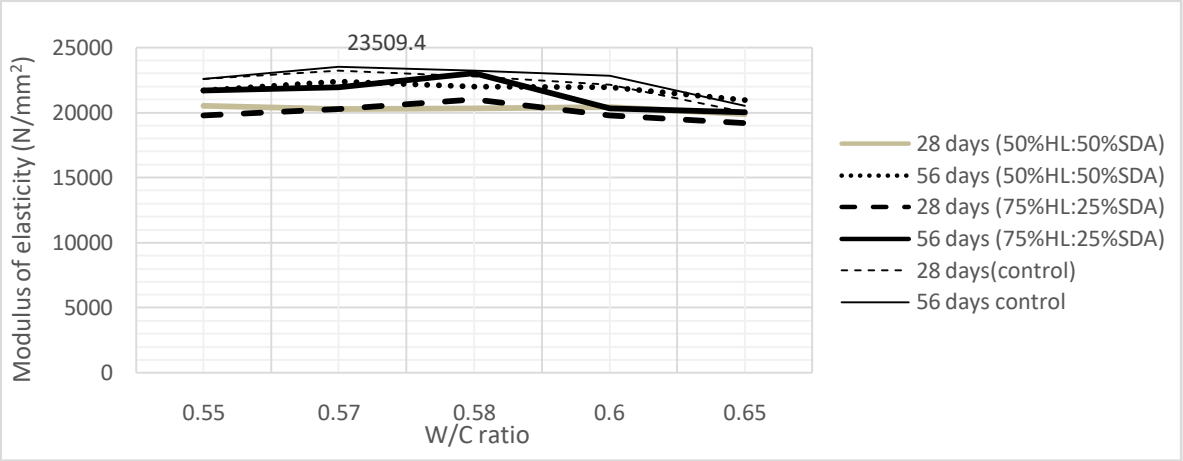

Fig. 7: Effect of water-cement ratio on the modulus of elasticity of HL-SDA cement concrete with 30% and 0% PC replacement.

Similar to the compressive strength, modulus of elasticity of the various concrete mixes increased up to their optimum w/c ratios before declining. Highest values of modulus of elasticity at 10% and 20% replacement of PC with HL and SDA occurred at the w/c ratios of 0.58 and 0.6 respectively. These were obtained from the 56 days specimen of 75%HL: 25%SDA. An optimum w/c ratio of 0.57 was recorded from the 56 days control mix. At w/c of 0.55, the modulus of elasticity of the 28 days concrete produced from 50%HL: 50%SDA was far less than those of the other mixes at 30% inclusion of HL and SDA. At 20% replacement, improvement of the modulus of elasticity of the concrete was observed only for w/c ratios of 0.59, 0.6 and 0.65 for the 75% HI: 25%SDA at 56 days.

IV. Conclusions

From this experimental studies, the following conclusions were made:

a. The best percentage replacement of PC with HL and SDA is 10%.
b. The concrete with proportion 75%HL: 25%SDA generally gave better strength results than those with 50%HL: 50%SDA.
c. The strengths of concrete with 75%HL: 25%SDA at 56 days, were higher than those of the control values.
d. Highest compressive strength values obtained at 28 days and 56 days were 27.56N/mm^2 and 30.40N/mm^2 respectively. This occurred at water-cement ratios of 0.57 and 0.58 for 10% replacement of PC with 75% HL and 25% SDA.
e. For 20% replacement of PC with HL and SDA, the 75%HL: 25%SDA is recommended for structural use. 50%HL: 50%SDA can still be used for structural works. But, the concrete must be allowed to cure for up to 56 days in other to generate the required strength needed before loading.
f. For safety purposes, 30% replacement of PC with HL and SDA should be avoided for structural purposes.
g. Optimum values of modulus of elasticity were recorded at 0.58 w/c ratio. These highest values were 24,673.88N/mm^2 at 28 days and 25,914.01N/mm^2 at 56 days, at 10% replacement of PC with 75% HL and 25% SDA.
h. The 10% inclusion of 75%HL: 25%SDA improved the modulus of elasticity of the concrete for the 75%HL: 25%SDA proportions. It resulted to a stiffer concrete.
i. At 20% replacement of PC with HL and SDA, only the concrete produced from the 75% HL: 25%SDA at w/c between 0.6 and 0.65, experienced an improvement in modulus of elasticity.
j. 30% replacement of PC with HL and SDA will reduce the stiffness of the concrete.

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The FARSE will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSE member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSE members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

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The FARSE is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSE can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSE member can decide its price and we can help in making the right decision.

The FARSE member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (MARSE)

The 'MARSE ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The "MARSE" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSE or William Walldroff, M.S., MARSE.

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The following benefitscan be availed by you only for next three years from the date of certification.

MARSE designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSE, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSE member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

AUXILIARY MEMBERSHIPS

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

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We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

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Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
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- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

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1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

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Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

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Tips for Writing a Good Quality Engineering Research Paper

Techniques for writing a good quality engineering research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of research engineering then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.

- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

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Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

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Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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