Piles and piled raft foundations analyses for Surface Paradise, Gold Coast sub-soil conditions

Piles et radiers empilés analyse pour le Paradis de la surface, Gold Coast conditions du sous-sol

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ABSTRACT: Analysis on the behavior of piled raft foundation in the Gold Coast area is presented in this paper. The ground condition is considered as three layers with a very dense sand layer sandwiched between the top medium dense to dense sand layer and the bottom stiff clay layer. This soil profile is simplified from available boreholes of building projects in Surfers Paradise of Gold Coast. A peat layer at deeper depth is not considered in the soil profile used for piled raft analysis in this paper. Parametric studies on varying the thickness and size of the raft, the length and spacing of the piles and the vertical loading magnitudes are main concerns and are presented in detail in this paper.

RÉSUMÉ : Analyse PLAXIS sur le comportement de radier empilés dans la zone Gold Coast est présenté dans le présent document. L'état du sol est considéré comme trois couches avec une couche de sable très dense en sandwich entre la partie supérieure de densité moyenne à couche de sable dense et la couche d'argile raide en bas. Ce profil du sol est simplifiée à partir de forages disponibles des projets de construction à Surfers Paradise Gold Coast. Une couche de tourbe en profondeur plus profonde est pas considérée dans le profil du sol utilisé pour l'analyse de radeau empilés dans cet article. Des études paramétriques sur variation de l'épaisseur et la taille du radeau, la longueur et l'espacement des piles et les grandeurs de chargement verticales sont les principales préoccupations et sont présentés en détail dans le présent document.

KEYWORDS: piled raft foundation, numerical analysis, finite element modeling.

1 INTRODUCTION

The Piled raft foundation is an intelligent geotechnical concept developed for reducing the raft settlement with the introduction of pile elements in a strategic manner. Piled raft concept was developed when the designers recognized the fact that every structure has a permissible settlement depending upon its serviceability requirement and so there is no need to eliminate the settlement in total. Available documentary evidences (Katzenbach etal, 2000; Poulos 2008) have shown that, structures that are tall as well as super tall have been supported on piled raft all over the world. In addition, the effects of raft flexibility on bending moments and differential settlement of the raft as well as axial forces and bending moments of the piles have been emphasized by recent studies of Clancy and Randolph (1993), Poulos et al. (1997) and Ta and Small (1997) in clay soil. Horikoshi and Randolph (1998) have carried out numerous of parametric analysis on performance of piled raft in non-homogenous clay soil. Based on the above many such buildings at Surfers Paradise along the coastal strip of Gold Coast are founded on piled raft foundations. But it appears that no published data relating to their performance is available unlike the cases of structures in Frankfurt. Hence a detailed study is being carried out analytically on the performance of piled raft on the prevailing soil conditions in Gold Coast area by the first author and his team.

The performance of piled raft foundation depends upon the effective interaction among the constituent elements and hence the parameters associated with the raft, pile and the supporting soil play a very important role in the behaviour of piled raft. It is also to be noted that the economics of piled raft design depends upon the cost of piles provided; further the behavior of the pile group is influenced by the properties of the raft and the pile spacing. Keeping the above in mind the present paper has been prepared focusing the attention on the effect of two very important parameters namely raft thickness and pile spacing on the settlement reduction, axial force on the pile and the pile bending moment. The analyses done here although not related to any specific case for the reasons mentioned elsewhere in the paper, the work intends to understand the behavior of piled raft and establish that the behavior is no different from the other cases. In the forthcoming stage the presence of peat will be considered and then in the three dimensional analyses these additional features will be considered along with the validation of the present results.

The ground condition at the Surfer Paradise, Gold Coast generally consists of alluviums, followed by residual soils and underlying by bedrock. A generalized subsoil profile based on the geotechnical investigation data available from four projects site located at the central Surfer Paradise was studied. The

geotechnical parameters were derived based on the in-situ test data.

2 SUBSOIL CONDITIO

The subsoil conditions at Surfers Paradise consist of alluvium materials underlying residual soil and overlying bedrock. Some 25 or more borehole data at four project sites extended to 50m below the ground surface have been collected to study the general subsoil condition at Surface Paradise, Gold Coast.

A layer of dense to very dense alluvial sand continued till a compressible peat was encountered. The peat layer was embedded within the alluvial dense sand and was not met with on every project site. The properties of this peat layer also appeared to vary on different project locations. Hence in the present analyses the peat layer has been omitted. Moreover, obtaining realistic parameters for such layers is very difficult with the conventional methods of soil investigation. Many times this peat layer exhibits brittle nature and so in this first part of our extensive programme this layer has not been considered in our analyses.

The soil profile generally returned to dense to very dense alluvial sand extended to approximate 25m below the ground surface. Beneath the alluvial dense sand layer, residual soils consist of stiff to very stiff clay and dense to very dense gravelly sand was encountered overly bedrock. The sedimentary type bedrock and was encountered at depth range from 32m to 40m below the ground surface. A typical profile is presented in Figure 1.

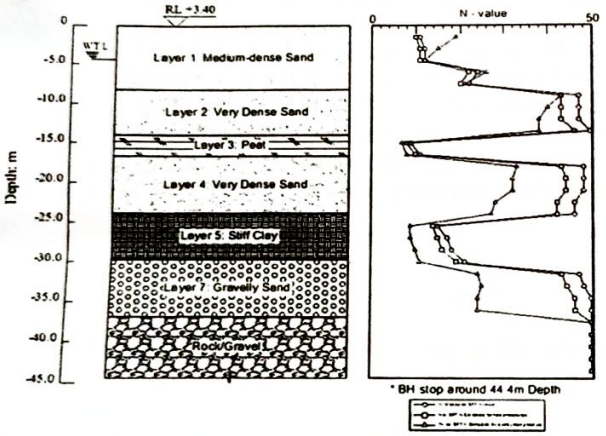

Figure 1. SPT N vs. Depth for Project site 3

3 GEOTECHNICAL PARAMETERS

The complex interaction between raft, pile and ground in the piled raft system could be investigated using the numerical modelling tool. Considering the difficulties involved in obtaining realistic parameter from the conventional soil investigation process an easier approach has been used with simple parameters which most of the geotechnical engineers can understand and recognize in a successful manner which has produced results of acceptable standards.

SPT test results are useful for processing of geotechnical profile, soil classification and deriving the geotechnical strength and stiffness parameters. Well established correlations of SPT with the engineering properties of soils are now available as shown by Schmertmann (1975), Poulos and Davis (1980). Numbers of Standard Penetration Test (SPT) test have been carried out for design of pile raft foundation. The geotechnical parameters adopted for the analysis is summarized in Table 1 and 1a.

4. PILED RAFT FOUNDATIONS ANALYSES

There are number of analytical methods to study the performance of piled raft, but considering the difficulties involved in obtaining such realistic parameter from the conventional soil investigation process, a simpler approach has been used with simple parameters which most of the geotechnical engineers can understand and recognize in a successful manner which has produced results of acceptable standards. For the purpose of simplicity in the analysis, a generalized three-layer subsoil profile for Surfers Paradise area consisting of medium dense sand, very dense sand and stiff clay have been adopted for the FEM analysis and the model is presented in Figure 2.

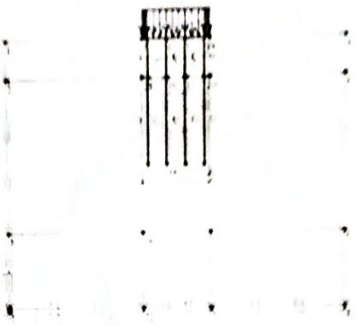

Figure 2 Diagrammatic view of boundary condition using for modeling

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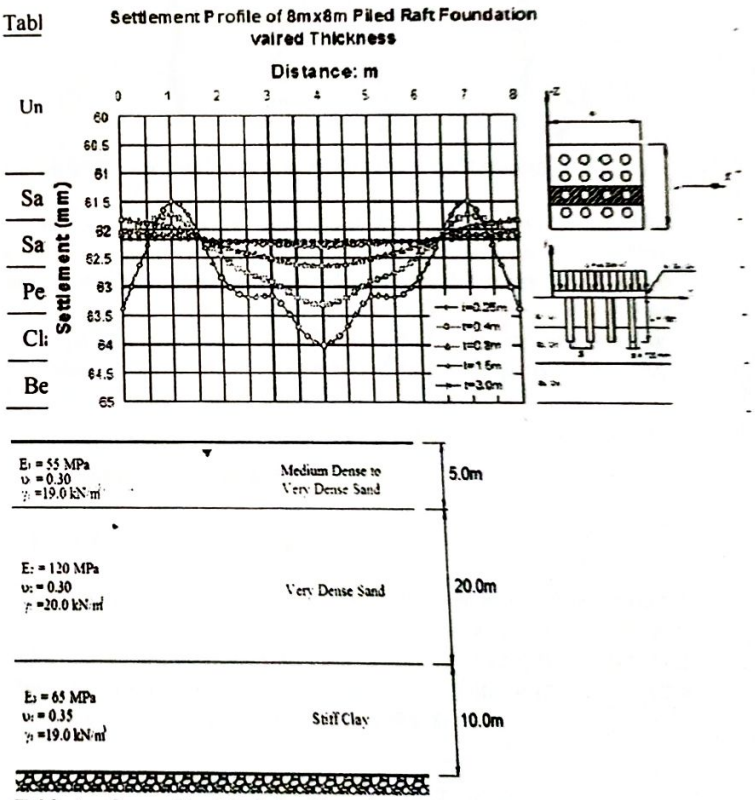

Table 1a. Generalized Soil Profile Adopted for Analysis

5 EFFECT OF RAFT THICKNESS

The effect of raft thickness was studied by varying the thickness of the raft from 0.25m to 3m. For the present the results of 8mx8m raft has been presented.

5.1 *Effect on the settlement*

Figure 3 presents the settlement profile of unpiled raft for a loading of 215kN/m². In studying the settlement profile rafts of

thickness upto 0,8m is treated is treated as flexible raft and thickness larger than 0.8m is treated as rigid raft.

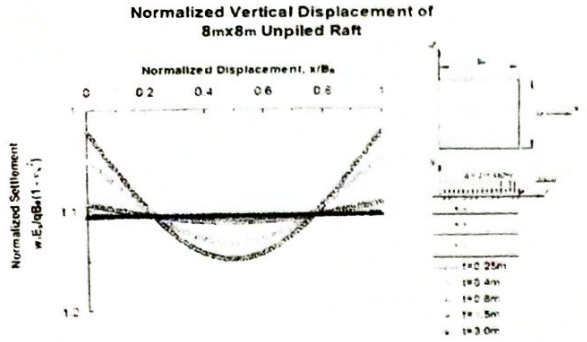

Figure 3 Vertical Displacement of a Raft w/o Pile

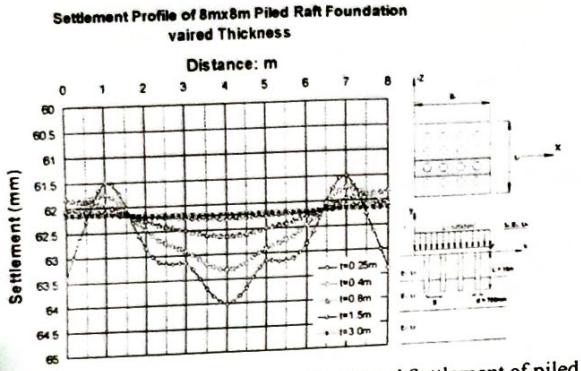

Figure 4 Effect of raft thickness on Computed Settlement of piled raft

Figure 4 presents the settlement profile of the piled raft. Comparing both the figures it is clearly seen that the addition of piles has not only reduced the settlement but in the case of flexible raft, it has altered the settlement profile also similar to that of rigid raft. The settlement reduction achieved is of the order of 43% and in addition the pile group adds rigidity to the flexible raft.

5.2 *Effect on the pile axial force distribution*

Figure 5 presents the effect of raft thickness on the axial force distribution on the pile. It is seen that the variation in the axial force is more pronounced in the case of outer pile than in the case of inner pile. In the case of outer pile in addition to the enhanced confining pressure with depth the loading from the overhang also gets added up. At the same time, due to the reduction in the enhanced confining pressure the reduction in the axial force is more rapid with depth. In the case of inner piles, the effect of increased confining stress is around the pile and so the variation in the axial force is small.

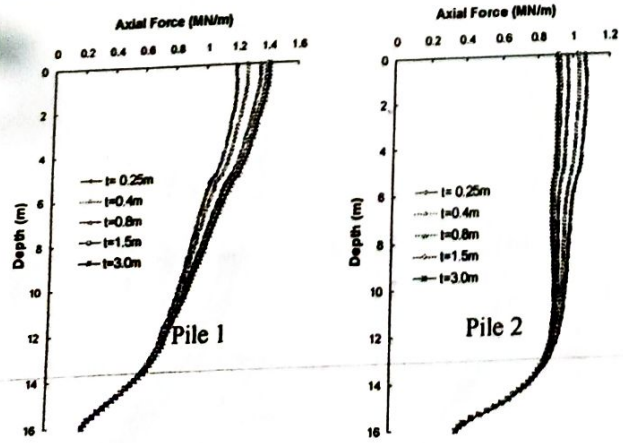

Figure 5 Effect of Raft Thickness on Pile Axial Force

But it is seen that beyond 10m level the reduction is more rapid and the magnitude of the axial force remains the same irrespective of the raft thickness. This feature indicates that the effective length of the pile remains as 0.8L. One very interesting feature exhibited by this study is that The effect of enhanced confining pressure is only upto a level 5m to 6mfrom the top.

5.3 *Effect on pile bending moment*

Figure 6 present the variation of pile bending moment. The figures indicate that the bending moment transferred on the outer pile is more than the inner pile. This may be due to the frame action and also due to the overhang. But the raft thickness appears to have no significant effect on the moment value on the outer pile and the inner pile.

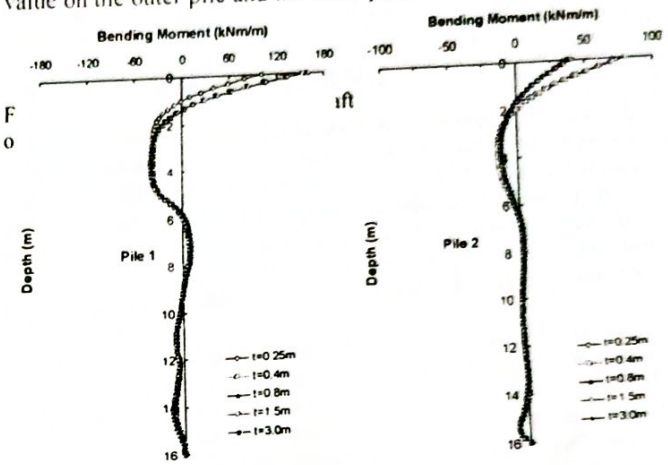

Figure 6 Effect of raft Thickness on Pile Bending Moment

The above study is significant for two reasons. The outer piles must have higher moment resistant capacity particularly when flexible raft is used. Also, the locations has some significance in the sense that the piles have to be more strategically placed keeping the settlement profile and bending moment variation of the unpiled raft depending upon whether the raft is rigid or flexible.

6 EFFECT OF PILE SPACING

6.1 *Effect on raft settlement*

The pile spacing becomes an important aspect mainly because it influences the raft bending moment. The study was done on a 0,8m thick raft adopting 0.7m dia piles. The lengths of the piles have been kept as 16m.The spacing of piles were varied from 3d to 7d where d is the diameter of the pile.

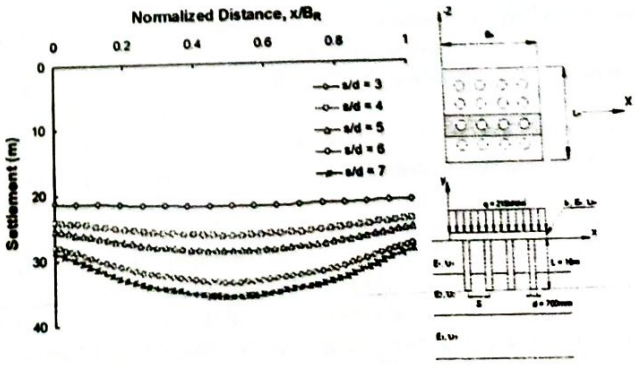

Figure 7 Comparison of Settlement Response for Different Spacing of Piles. Q = 215 kN/m²

The Figure 7 presents the variation of pile spacing on raft settlement. When the spacing is 3d there is hardly any variation in the settlement profile. The settlement pattern is almost a straight line indicating the system behaves as a fully piled foundation. When the spacing is increased to 4d and 5d small differential settlement was observed but the difference between the edge and the center is negligible. But when the spacing gets more than 5d then the differential settlement becomes appreciable, indicating that 4d to 6d is an ideal spacing for the raft design to be economical.

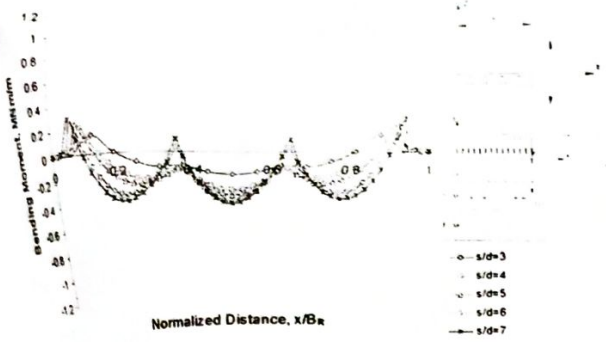

Figure 8 Comparison of Piled Raft Bending Moment Response - Variation of pile spacing

Refer to Figure 8. The variation of raft bending moment is more pronounced when the spacing becomes more than 5d. It was observed that the difference in the raft bending moment between the case of 4d spacing and 5d spacing is less than 5d to 6d and 6d to 7d. At higher pile spacing the raft has a tendency to behave as continuous beam.

6.2 Effect *on axial force and bending moment on the piles*

Refer to Figure 9, it is seen that the axial force variation is more pronounce in the case of outer pile than in the case of inner pile. Beyond 5d spacing the fall in the axial force is more rapid compared to the smaller spacing. It was also observed that the axial force at the pile head is more in the case of outer pile than in the case of inner pile. The variation between the outer pile and inner pile is more when the spacing is more than 5d indicating that when the spacing is larger the outer pile must have a higher capacity than the inner pile. But it is seen that beyond 0.8L irrespective of the spacing the axial load variation is negligible and the rate of fall of axial load is more rapid beyond 10 m or say 0.6L.

The trend of the variation in the bending moment is same as in the previous cases (Refer Figure 10). The outer pile is subjected to a higher bending moment than the inner pile. Beyond 6m level the bending moment was becoming nil as in all the earlier cases.

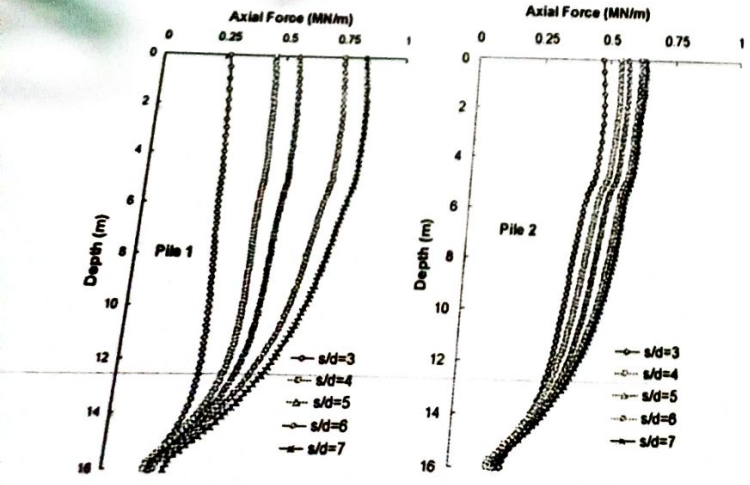

Figure 9 Effect of Pile Spacing on Pile Axial Load. q = 215kN/m²

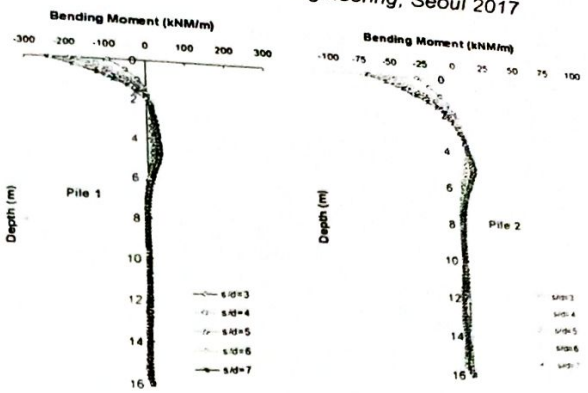

Figure 10 Effect of Pile Spacing on Pile Bending Moment q = 215kN/m²

7 SUMMARY AND CONCLUSIONS

The present study has established that simpler approach with simple parameters which most of the geotechnical engineers can understand and recognize can be used in a successful manner to get results of acceptable standards. An overall study of the axial stress and bending moment distribution indicates that the effect of increase in the confining stress is not felt beyond the pile length of 0.6L, when the raft width is less than the pile length.

The importance of locating the piles in a strategic manner is established by the change in the raft bending moment, settlement value and the profile compared to the plain raft behaviour. The variation in pile length and diameter can also be attempted. The study has shown that the unpiled raft design plays a very important role in designing the piled raft in an effective manner.

8 ACKNOWLEDGEMENT

Constructive and most valued critical comments were kindly provided by Prof. Harry G Poulos and many practicing engineers. The authors have tried to accommodate refinements and in particular 3 D analyses are now being performed in this continuous research at Griffith University under Dr. Erwin Oh's, leadership with additional parameters collected.

9 REFERENCES

Clancy, P. and Randolph, M. F. (1993). Analysis and Design of Piled Raft Foundations. *Int. Jnl. Num. Methods in Geomechs.*, 17, 849-869.

Horikoshi, K., & Randolph, M. F. (1998). A contribution to optimal design of piled rafts. *Geotechnique*, 48(3), 301-317.

Poulos, H. G., Small, J. C., Ta, L. D., Sinha, J., & Chen, L. (1997). Comparison of some methods for analysis of piled rafts. *Paper presented at the 14th international conference in soil mechanics & foundation engineering, Hamburg, Germany.*

Poulos, H. G., Davis, E. H. (1980). *Pile foundation analysis and design.* New York: Wiley.

Schmertmann, J. H. (1975). Measurement of in-situ shear strength. Paper presented at *the ASCE special conference on in-situ measurement of soil properties*, USA.

Ta, L. D., & Small, J. C. (1996). Analysis of Piled Raft Systems in Layered Soil. *International Journal of Numerical and Analysis Methods in Geomechanics*, 20, 57-72.

Katzenbach R., Arslan V. and Moorman ch. (2000b), 'Piled Raft Foundation Projects in Germany', Design Application of Raft Foundations, Ed, by J.A. Hemsley Thomas Telford Ltd, pp. 323 – 391.

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A Critical and Comparative Study on 2D and 3D Analyses of Raft and Piled Raft Foundations

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ABSTRACT: The piled raft foundation has gained a very high level of acceptance as a foundation system whenever settlement alone governs the design. In the design of piled raft many of the traditional methods could not be applied due to the complex nature of interactions involved. Hence there is a need to use detailed three dimensional finite element analyses for the final design. But in the initial stages of design a simpler but effective analytical process need to be used to save the computational efforts. Since the primary requirement in the piled raft design is the design of optimum pile group to achieve the desired settlement reduction, through number of trials, the applicability of simpler two dimensional analyses are examined to save the computational efforts during the initial trials. It was found that simple two dimensional analyses provide results of acceptable accuracy for the design office requirements.

KEYWORDS: Plane strain, Axisymmetric, ANSYS, PLAXIS.

1. INTRODUCTION

The exponential growth in the infrastructure development has forced the designers to accept any ground condition and have to face the challenge of designing a suitable foundation system which will satisfy the safety and economy irrespective of the ground conditions. In the design of foundation system for structures that cannot tolerate settlements, the aspect of balancing the performance and cost, had always been a challenge for the foundation designers. Due to the complexity involved in the soil structure interaction analyses, required for an optimum design, designers have so far been resorting to the traditionally designed pile foundations system permitting very small limiting settlements. Such a foundation system would satisfy the safety and the serviceability requirements effectively but may not satisfy the economic requirements both from cost and time point of view. In many cases raft was found to satisfy the bearing capacity requirements but the control of settlement would not possible. In these cases the presence of the raft and its capability to transfer the load to the soil was completely ignored and the piles were designed as though they would take the entire structural load. Keeping the ve objective in mind researchers like Burland (1995) Burland et al., (1997), and subsequently Poulos (2001) had brought out the use of piles with the raft to reduce the settlement of the raft. This had led the advent of the combined piled raft foundation system, which provides a skilful geotechnical concept to design the foundation for structures which are sensitive to settlements.

The concept of piled raft foundation system recognizes the fact that any structure has a certain amount of permissible settlement and the economy of the foundation design depends upon reducing the settlement to the permissible level rather than eliminating it in total. In the combined piled raft system the addition of piles enhances the stiffness of the entire system in the initial stages, and at higher loads provides the additional capacity for the raft to take a higher load at any given settlement compared to the unpiled raft (plain raft).

Piled raft foundation system transfers the load by means of a complicated three dimensional interaction among the constituent elements namely the pile, raft, and the soil. Unlike the traditionally designed pile group wherein the interaction is only between piles and the soil, in the case of piled raft there are four interactions namely raft and the soil, pile and the soil, raft and the pile and pile to pile. Further in the case of piled raft the pile group alone is not intended to ensure the safety of the system but it is the combined system of raft, pile and the soil ensures the safety of the structure. Hence in designing the piled raft it is not the pile capacity alone to be considered but the combined capacity of the whole system has to be considered at any given settlement reduction. Therefore the analyses become complicated.

Studies on the behaviour of piled raft can be classified broadly under three heads namely small scale model tests with 1g model (Weisner and Brown,1978; Balakumar,(2008); Turik and Katzenbach(2003)); centrifuge models (Horikoshi,1995) and observational methods (Katzenbach etal.,(2006), Yamashita etal., (1994) Hooper (1974), Poulos(2008)). The recent developments in the computational facilities in the form of FEA supported by the softwares and hardwares have enhanced the interaction process among the various methods of studies. Consequent to this number of tall and heavily loaded structures have been supported on piled raft and the performance of some of these piled rafts have been monitored and the results are being used to refine the design in the future (Poulos, 2008; Yamashita et al, 2010).

2. OBJECTIVE AND METHODOLOGY

The main problem the designers were facing was that many of the traditional methods of analyses could not be applied since they require a high level of extrapolation and approximations which were beyond the comprehension of past experience. As Russo (1998) has pointed out, to move from the traditional capacity based design to settlement based design method, the analyses must be capable of taking into account properly the soil structure interaction within the foundation system. Finite element analyses are one method which is by far well developed and found to be more suitable to analyze the piled raft problem. However, it has been found that in order to reduce the computational efforts, under many circumstances the rigors of the method has to be diluted by some approximations and simplified assumptions. While a number of simplified methods have been developed to analyze the large pile groups, no such method appears to be available for the analyses of piled raft. The present work makes an effort to establish the applicability of simple two dimensional models for the preliminary analyses and design of piled raft.

Two 1g models of piled raft (circular and strip) whose load settlement response had been established (Balakumar, 2008) were subjected to axisymmetric analyses and plane strain to establish the accuracy of the analytical procedure. Typical problems, one hypothetical and the other from a monitored piled raft were also subjected to analyses with PLAXIS 2d and PLAXIS 3d based on

ate on piles approach and equivalent pier method to establish that he type of softwares has no influence on the results.

3. DESIGN PROCESS

The design of piled raft has got three stages as pointed out by Poulos (2008) in many of his publications. They are: i) Preliminary, ii) Approximate iii) Detailed Analyses. Since there are three stages of design, it becomes necessary that appropriate analyses methods have to be adopted so that there will not be any unnecessary loss of computational time and efforts. Further for the detailed analyses the main requirement is the evaluation of in situ geotechnical parameters which will be the critical input data. In the geotechnical design the most difficult part is the evaluation of the in-situ parameters of the soil. This process can prove to be expensive but the accuracy of the output from the analyses largely depends upon the reliability and accuracy of the parameters and methods adopted for their evaluation. The first and the second stages of design and analyses must be such that with reasonably minimum computational efforts it must be able to establish a reasonable data and the limitations of the available parameters so that any additional requirements can be planned and obtained.

The satisfactory performance of piled raft largely depends upon the performance of the pile group of piled raft in providing the initial stiffness and then allows the raft to have a higher capacity by functioning as settlement reducer. Hence after ascertaining the feasibility of the piled raft to support the structure, a preliminary analysis has to be done to finalize the conceptual details of the constituent elements. Primarily the number, lengths of the piles, the load shared by the pile group are the essential parameters in addition to the properties of the supporting soil layers. In the case of the piled raft the pile group capacity and the overall capacity of the piled raft play an important role.

The second stage of analyses has to produce these data in a reliable manner such that when used in the final analyses, the analyses will produce a design which need not be subjected to any iteration process. This requirement makes the procedure to be more realistic and simple enough such that the computational efforts are minimum and economical. Even though the existing methods can provide a design approach, these involve a very detailed computational effort, not really warranted for the second stage of design, from the commercial design organization point of view. Therefore it is essential to have a relatively simple design procedure so that the second stage of work can give adequate but reasonably ccurate data for the final analyses.

In the third stage once the parameters are finalized a detailed analyses need to be done to effectively establish the design forces and the economics by confirming the achievement of the settlement reduction required, and the load shared by the pile group at the required settlement reduction and other needed parameters needed for design is established. Also the ductile behaviour is also established by assessing the shaft friction distribution and ensures that the tip stresses are very small.

In most of the cases, such parameters are obtained either from laboratory tests or from standard correlations between tests like SPT and Es values, which can affect the accuracy of results. However over the past few years there is a considerable shift from the laboratory testing to in-situ testing and this has led to the use of the results from in situ tests such as CPT and pressure meter tests extensively to determine the stress strain characteristics and essential parameters like the in-situ elastic modulus of the soil over the length of the pile. A well tried procedure for predicting such parameters along with the shaft friction development has been published by Frank et al., (1991) using pressure meter tests.

However it appears that the phenomenon of the interaction between the constituent elements has not been studied in detail. The complex interaction can become favorable like increase in the group capacity or unfavorable like causing additional settlement. The study on the interaction behaviour gains importance as in the case of piled raft the interaction takes place between the pile – raft –and the soil.

4. SELECTION OF SOFTWARES AND ANALYSES

The role of analyses in the design process becomes clear only when the design objectives are established. The facets of analyses such as identification of appropriate parameters and a clear understanding of empirical methods play a very important role. Since the piled raft analyses is a three dimensional problem any particular software must have provisions to represent the continuum in a realistic manner. This would mean that the software must have a good element library, an array of material models and provisions for mesh refinement. Hence the selection of software also plays a very important role. Further problems can arise if the elements representing the soil become too large and interface elements are not used. To avoid this, solid elements are used with or without interface elements and the properties are assigned to the soil with adequate care.

Considering the various uncertainties coupled with the difficulties involved, there is every possibility of designers getting confused to decide the methodology for the preliminary design and analyses. This appears to have resulted in the designers adopting empiricisms in the analyses. Therefore it is felt that there is a need for studying the extent to which simpler methods can be followed and when the detailed three dimensional analyses is necessary. In the present work three different cases are considered namely linear elastic analyses, axisymmetric and plane strain conditions in modelling and detailed three dimensional analyses are carefully discussed. The details of finite element analyses carried out are discussed in the various publications of the author (Balakumar, 2008; Balakumar and Ilamparuthy,2010). For this purpose the results of small scale 1g model tests on circular piled raft (Balakumar and Ilamparuthy, 2005); and rectangular piled raft Balakumar and Ilamparuthy, 2008) are studied with ANSYS. For getting the raft contact stress, pile head and tip stress along with shaft stress distribution 3-D nonlinear analyses has been performed on the circular piled raft. The results from the 1g tests on the rectangular piled raft are compared with the load settlement response from the plane strain analysis with ANSYS. In all these cases the loading was applied in the form of uniformly distributed pressure load as done in the case of model tests. The result obtained by monitoring the piled raft supporting a twelve storied building is validated with three dimensional analyses, by equivalent pier method. One grid was taken to be analyzed with plate on piles method using PLAXIS-2D and PLAXIS-3D.

To revalidate the analyses a hypothetical problem of piled raft resting on a generalized soil profile obtained from various reports of investigations done in GoldCoast, Australia has been analyzed with PLAXIS 2D and PLAXIS 3D and are compared. The details of the material model and the procedures are explained in detail by the second author (Min Huang, 2006). The results are discussed to arrive at a conclusion of when simpler methods can be used and when three dimensional methods become essential. The essential requirements in all these things are the study of the mechanisms of failure. In this present case this has been based on the 1g model tests on piled raft.

5. PILED RAFT-MECHANISM OF FAILURE

Before reviewing the merits and demerits of the different types of analytical procedures the behaviour of piled raft at various settlement levels need to be discussed. The behaviour is explained in the following parts based on the results of 1g model tests conducted by the first author (Balakumar 2008). As pointed by Murray and Geddes (1989) although the results of 1g tests do not provide a direct comparison with full scale behaviour, they can be of value in providing an understanding of the behaviour patterns and can be a

ide to full scale performance particularly when examined in onjunction with the developed theoretical solutions

Figure 1 (Balakumar etal., 2005) presents a comparison between the load settlement response of free standing pile group (wherein the raft is not in contact with the bed) and the pile group of piled raft. In the case of free standing pile group, it is seen that once the friction is overcome the pile group settles instantaneously where as in the case of pile group of piled raft even after the friction is overcome the pile group continues to take further load;. The settlement level at which the friction is overcome is termed as critical settlement and this magnitude is far higher than that of free standing pile group. It can also be seen that at any particular settlement level the load taken by the pile group of piled raft is higher than the free standing pile group The enhanced carrying capacity of the pile group of piled raft is mainly due to the enhanced confining pressure caused by the raft transferring the stress due to the applied load on the soil surrounding the piles.

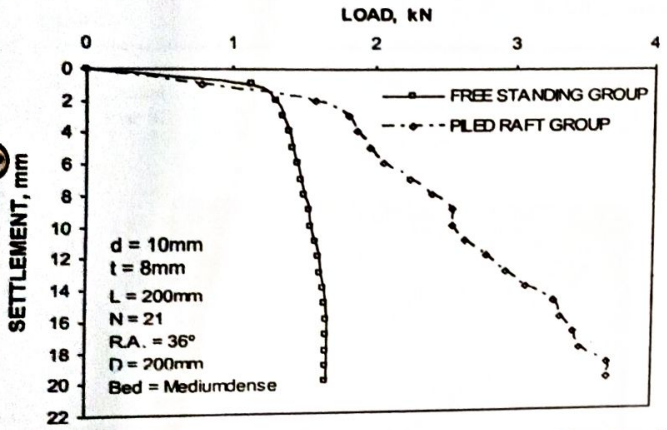
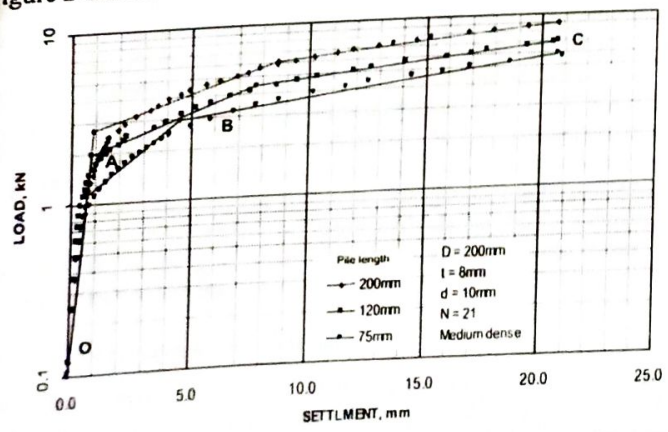


Figure 1 Comparison of load-settlement response of free standing pile group and pile group of piled raft

Figure 2 presents the characterised load settlement response and Figure 3 is a plot between the load sharing ratio α_{pr} which is the load carried by the pile group to the total load carried by the piled raft at any particular settlement level and settlement of the piled raft which is the load sharing response of the piled raft. From the Figure 2 it can be seen that the load settlement response of piled raft has three phases. Phase OA exhibits a very high stiffness indicating that the pile group mobilizes the entire friction and the major part of the applied load is taken by the pile group. In the Figure 3 till a ettlement level of 1.5 mm to 2mm the load sharing ratio is very high confirming this. The phase AB is the elasto plastic response where in the loss of stiffness is gradual and the load sharing ratio drops down till a settlement reaches 5mm to 6mm; the phase BC shows a plastic response wherein even for a small increase the loss of stiffness is very rapid although the behaviour exhibited is elastic work hardening.

Figure 2 Characteristic response of piled raft for various pile lengths



Correspondingly as seen in Figure 3 the load sharing ratio remains constant with the increase in the settlement indicating that the pile group at this stage becomes a non load bearing member but functions as settlement reducer for the raft. The behaviour was found identical irrespective of the shape of the raft and the physical features of the piles.

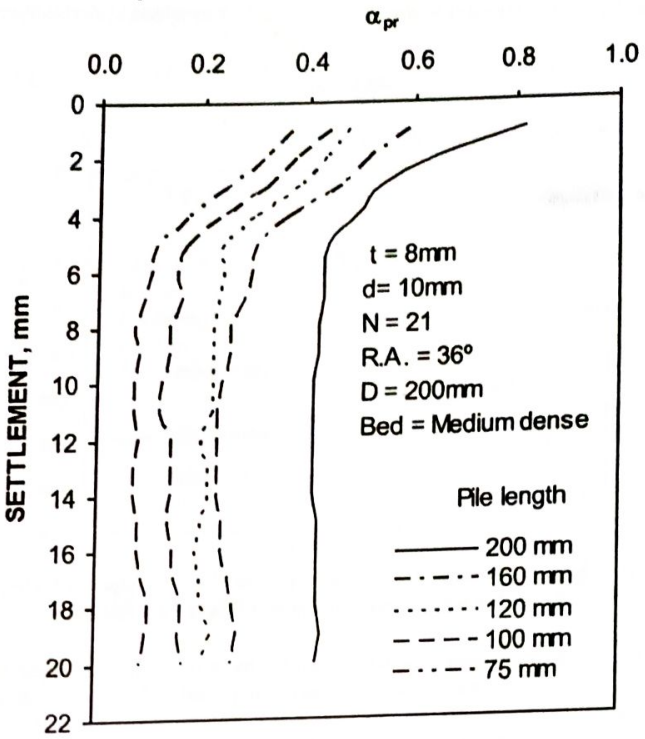


Figure 3 Settlement v/s LS ratio α_{PR} for 10mm dia pile

The ratio α_{pr} is defined as the ratio between the amount of load (shaft resistance + base resistance of all piles) shared by the piles at a given settlement of piled raft (Q_p) to the total load on the piled raft causing same settlement (Q_{pr}).(Balakumar,2008)

$$\alpha_{pr} = Q_p / Q_{pr} \qquad (1)$$

where $Q_p = Q_{pr} - Q_r$ and Q_r = load shared by the raft at the same settlement.

Therefore the mechanism of the piled raft behavior has three phases and it is the second phase, namely the elasto plastic stage is very critical for the design and perhaps we can say that this is the limiting level of piled raft for serviceability requirement. Based on the above Balakumar et al., (2013) had presented a quantitative assessment of interaction and it was found that the interaction factor was found to be around 0.6 to 0.8 which is the maximum. Balakumar et al., (2015) had presented that the limiting capacity shall be restricted to the end of elasto plastic stage when the settlement level reaches around 5% of the pile length.

6. NUMERICAL ANALYSES

6.1 Linear Analyses

The linear analysis has been carried out in the case of circular piled raft to serve as a preliminary study and also to check and compare the settlement level up to which the results of 1g model studies and the numerical analysis agree with each other. The three dimensional linear analysis using ANSYS software was carried out on the circular piled raft with 21 piles in radial grid. Half model was used as given in Figure 4.

ıble 1 and Table 2 present the basic data of the circular piled raft nd the bed materials characteristics.

Table 1 Properties of circular piled raft

Raft		Pile				
Dia, mm	Thickness, mm	Dia, mm	Length, mm	Area ratio	E_r N/mm^2	μ_r
200	8	10	160	5.2%	3000	0.30

Table 2 Properties of bed material

Material	γ' kN/m^3	ϕ	E_s N/mm^2	μ_s	State of compaction
Poorly graded sand	15.5	37.5^0	35	0.30	Medium dense

Figure 4 Finite element mesh for piled raft (linear analysis)

The ANSYS material table contains more than 40 material models. Out of these, the linear elastic and the multi-linear isotropic hardening material (MISO) model are used to simulate the linear elastic and the nonlinear behaviour of the soil respectively. The soil medium below the raft was modeled using an eight-node brick element (SOLID 45) having three degrees of freedom of translations in the respective co-ordinate directions at each node.

Figure 5 presents the comparison of the load settlement response of the piled raft obtained from the 1g model test and the linear analyses. A study of the curves indicates a very close agreement upto a settlement of 1.5 to 2.0mm at which the full friction was mobilised. This settlement value can be called as critical settlement. As the load increases the linear analyses exhibited a very high stiffness indicating that the load sharing behaviour is independent of the stress level. But the 1g model test showed non linear behaviour beyond the critical settlement and hence the linear analyses is not applicable to capture the load settlement response of piled raft over the entire load range as the response changes to elasto plastic and plastic behaviour. However the linear analyses can be considered for use when the loading is small namely within the elastic limits for obtaining the settlement.

6.2 2-D Axisymmetric Analyses

The axisymmetric analyses is carried out using the same circular piled raft model used for the 1g test with the intention of establishing the adequacy of the method in predicting the load settlement response and the settlement reduction possible for the given pile layout. The same model is used for the 3D analyses subsequently.

The axisymmetric analyses retains the essential features of the three dimensional analyses. Hooper (1978) in his study on the behaviour of the Cavalry Barracks building had used the axisymmetric analyses to study the settlement response of the piled.

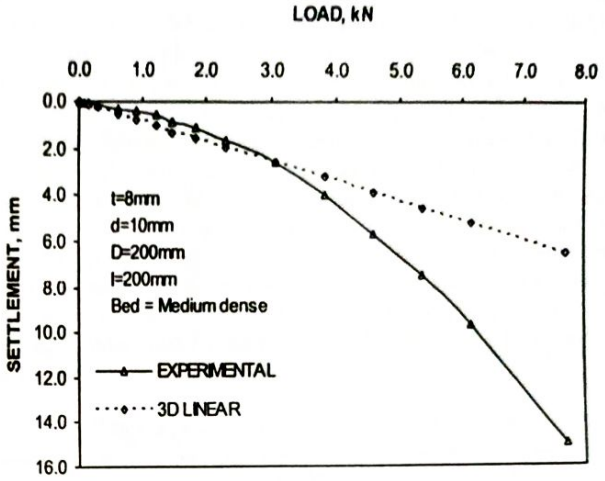


Figure 5 Comparison of load – settlement response between ANSYS (linear) and model test results for circular piled raft

raft supporting the above structure. In the analyses the pile cap was assumed to be flexible. The procedure simulates each concentric row of piles by a continuous annulus with an overall stiffness equal to the sum of the stiffness of each individual pile. The modulus of elasticity of each annulus was taken as an equivalent modulus .The problem is a large deformation problem. The equivalent modulus was worked out as outlined by Desai (1974) for the plane strain wall and subsequently used by Prakoso and Kulhawy (2001) for piled raft analyses using plane strain model. No slip between the raft and the pile is implicit in the finite element formulation of the problem. In this case the problem is much simpler satisfying the requirement of the normal stress at the interface of soil-raft along which the common nodes joining with dissimilar properties.

Here each row of piles in the plane is converted into a plane strain pile wall of an equivalent pile Young's modulus as indicated in the equation below

$$E_{eq} = \frac{n_{p-row} A_p E_p}{L_r B} \qquad (2)$$

where, np-row : number of piles in a row
A_p : area of pile crosses section
E_p : pile Young's modulus
L_r : raft length in plane
B : pile diameter.

Figure 6 presents the model. The soil was idealized by MISO model. The features of the model were maintained as the same as that used in the earlier analysis. The analysis was carried out with the pressure load applied in steps of small increment. This case also the agreement between the two was very close till the critical settlement level of around 2.0mm

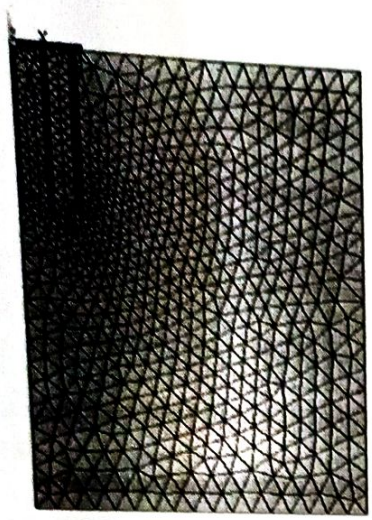


Figure 6 Axisymmetric model and mesh used in ANSYS analysis

Figure 7 presents the comparison of the load settlement response obtained from the 1g model test and the axisymmetric analyses. As the load increases the model was predicting a higher stiffness and at the maximum load the variation was of the order of 10%. Figure 7 represents the characteristic load settlement response obtained from the 1g model tests and the axisymmetric analyses. The very close agreement upto the elasto plastic region clearly indicates that the axisymmetric analyses can be used for circular piled raft. The stiffer behaviour in the analyses can be attributed to the idealization of the pile group as a pile wall comprising of two dissimilar materials. Russo and Viggiani (2001) has explained that the accuracy of available computer software is probably no better than +/_ 20% but in this case it is only 10%., although the medium is homogeneous poorly graded sand. Katzenbach (2005) had also observed that the implementation of linear and non-linear soil modulus depends upon cases under study as the results can vary to an extent of 20% to 30%. It is to be noted the change in the slope of the load settlement curve indicates the change in the load haring process between the pile and the raft. This was not exhibited in the linear analyses. In the case of axisymmetric model higher stiffness is mainly due to the computation of equivalent modulus which comprises of mainly the soil prism which has not been properly accounted for.

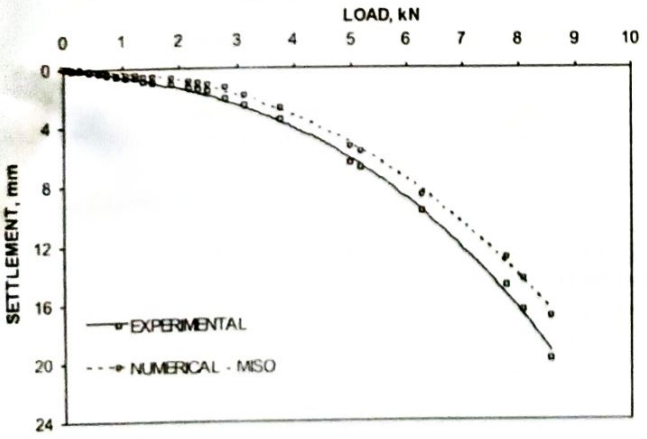


Figure 7 Comparison of load-settlement behaviour between numerical and 1g model test data (D=200mm, t=8mm, d=10mm and l=100mm)

However the study truly represents the non-linear behaviour and is capable of identifying the change in the load sharing behaviour of the pile group. Hence this procedure is adequate for predicting the behaviour of circular piled raft or a piled raft with radial pile layout or in a circular pile layout with square grid pattern. But the limitation in this case is that the load sharing behaviour or the ratio cannot be estimated as the contribution of the soil prism in the annulus cannot be separated.

6.3 Plane Strain Analyses

The piled rafts supporting a rectangular storage structure have mostly piles placed in rows and columns with the raft covering them as common cap. Under favorable circumstances this can be designed as piled raft. A simpler procedure for analyses can be a plane strain analyses. To establish the nature of such behaviour a 1g model test was carried out on a rectangular piled raft (Balakumar and Ilamparuthy, 2010). The bed material used is the same as in the previous tests namely medium dense poorly graded Palar sand. The model had two rows of piles at 4d spacing (where d is the diameter of the pile). The plane 42 elements were used and the problem was defined as plane strain. The value of E_s and the bed density were retained as same in all the studies. The equivalent modulus for the plane strain pile soil was computed using the same expression as done by Prakoso and Kulhawy (2001).The details of piled raft and bed material is presented in Table 3.

Table 3 Details of piled raft and bed material

Raft			piles		Sand bed		
Size B×L	Thickness mm	N	Length mm	Area ratio %	Bed density kN/m^3	E_s KN/m^2	ν_s
70×200	8	14	75	7.85	15.5	35	0.30

Figure 8(a) provides the model. The settlement contour, Figure 8(b) indicates a maximum settlement of 12.5 mm and 11.4mm at its center and the edges respectively. At pile locations the settlement obtained were 11.4mm and 11.3mm and the pile tip settlement was found to be 8.4mm.

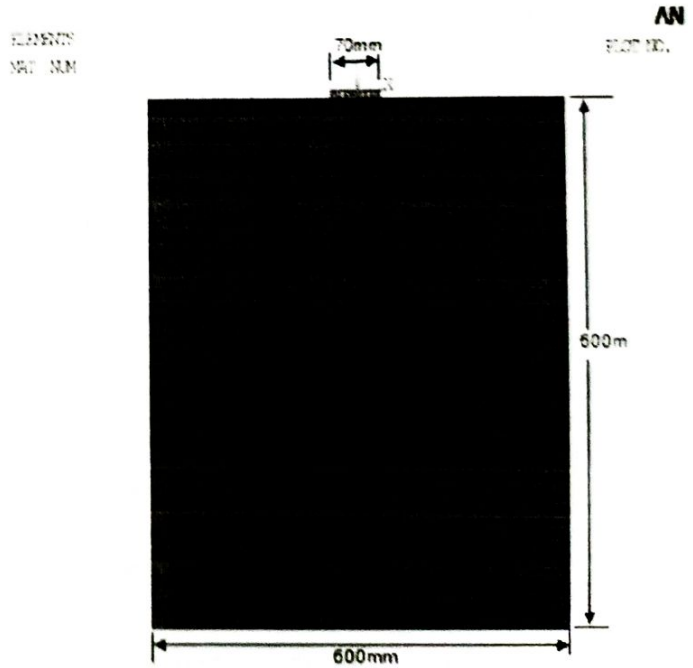


Figure 8(a) Rectangular piled raft model with finite element mesh used in plane strain analysis of ANSYS

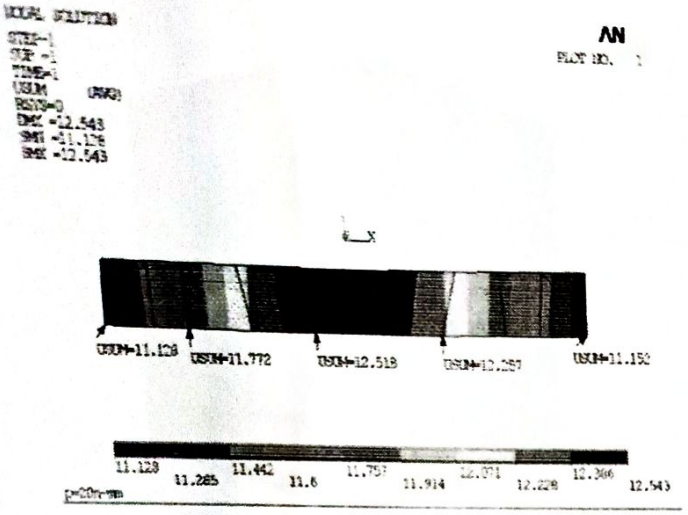


Figure 8(b) Settlement of piled raft at the load of 1.55 kN

Figure 9 presents the comparison of the load settlement response obtained from the 1g model tests and the numerical analyses. The plane strain model has predicted a stiffer behaviour and the variation increases as the load level increases. It is seen clearly that the two dimensional plane strain and axisymmetric models predict identical response of higher stiffness mainly due to the idealization of the equivalent modulus. Consequent to this the load shared by the pile group based on the plane strain analyses is expected to be higher because of the influence of the soil prism.

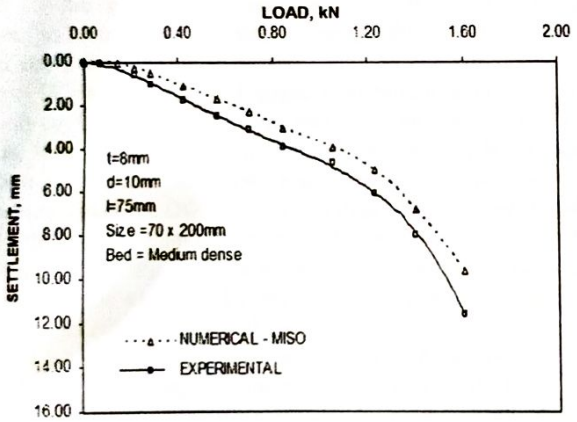


Figure 9 Comparison of load-settlement response between ANSYS and test data for rectangular piled raft

6.4 Non Linear 3D Analyses of 1g Model Tested

From the previous study it is seen that the axisymmetric model and the plane strain model which could bring out the load settlement response but because of the stiffer behaviour they exhibited, the load sharing ratio and the pile shaft stress distribution can be on the higher side and may not be realistic. Hence it was decided to conduct a three dimensional non linear analysis.

For the three dimensional analyses the bed density was retained as medium dense as in the two previous cases with the phi value as 37.5 and the unit weight was taken as 15.5 kN/m^3. The bed material was represented by MISO model. Solid 45 elements with three degrees of freedom at each node were taken to represent the bed material.

The soil was idealized as an isotropic homogenous half-space. The nonlinear behaviour of the soil is modeled using the multi-linear isotropic hardening (MISO) material model of ANSYS. This model incorporates the Von-Mises yield criterion with associated flow rule and isotropic work hardening.

To provide the required parameters as the input for the MISO model triaxial tests were conducted on dry Palar river sand used in the experiments. The test was conducted at an average unit weight of 15.5kN/m^3 (15.5 + 0.1kN/m^3) under different confining pressures. A value of 0.35 was used in computation for Poisson's ratio.

In selecting the elements for the various structural components of piled raft, certain important aspects as given in the manual were considered. When elements having different degrees of freedom are selected, there will be inconsistency at the interface. When elements are not consistent to each other, at the interface, the analyses may not transfer appropriate forces or moments among the different connecting nodes of the various elements at the interface. To ensure compatibility between the elements used for modelling different structural elements, they must have the same degrees of freedom. The DOFs must overlay each other and must be continuous across the element boundaries at the interface. For example if a solid 45 element is joined either to shell 63 or beam 4 element, the nodal forces corresponding to displacement DOFS will be transmitted to the solid element. But the nodal moments corresponding to the rotational DOFS of the shell element will not be transmitted to solid 45. Although these conditions may not invalidate the analysis, it is appropriate to select compatible elements for various components of structure. Solid 45 elements were used to model raft, pile and soil continuum.

In the analysis the bed dimensions were kept same as that of the lab model tested in the laboratory. The raft and pile were modelled as solid 45 elements in order to maintain the element compatibility. Reasonable mesh refinement was done with an achieved aspect ratio of 5. Required checks were made for element continuity and continuity at nodes. The material property was fed in the form of stress-strain data. The mandatory check for proper meshing at various levels, element continuities etc. were made and then the solution command was activated to solve the model after applying the load. The load was applied as pressure in small increments till the load on the raft equal to the final test load. Figure 10 shows the quarter model including finite element meshing adopted in the analysis. At the maximum load of 8.1 kN the settlement was found to be 17.7mm.

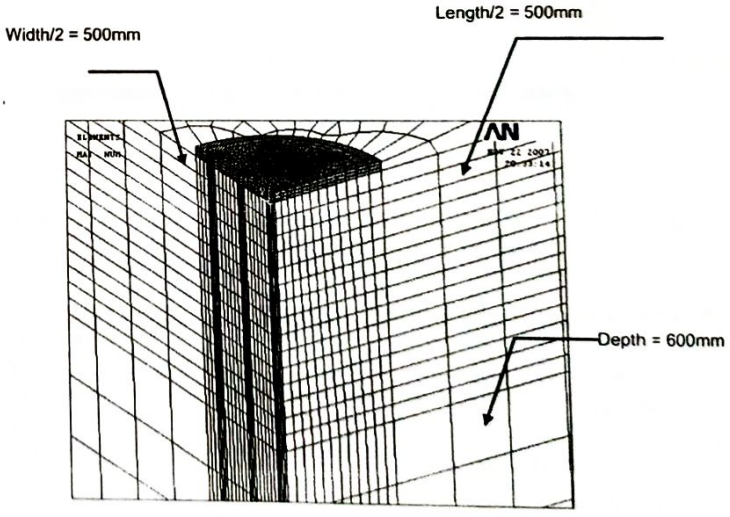


Figure 10 Finite element mesh of a circular piled raft (Quarter model) used in ANSYS analysis

Figure 11 presents the settlement contour. From the contour the piles had settled uniformly and the settlement was 15mm.The settlement of the soil below the raft decreased with the depth and the influence was up to a depth of 2.5 times the raft size.

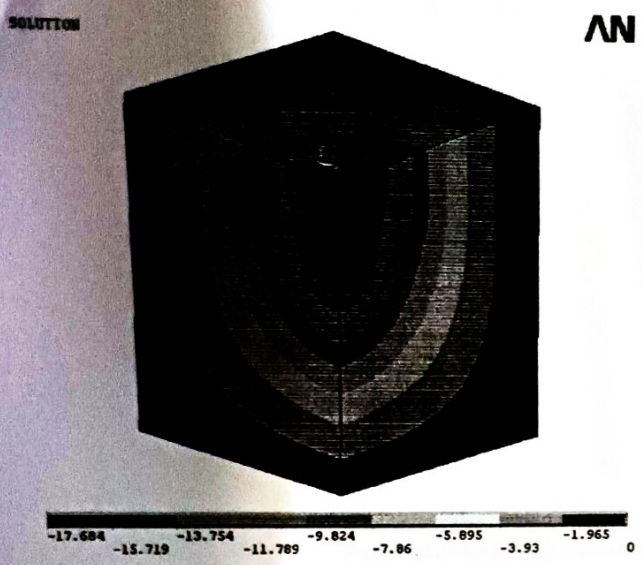


Figure 11 Settlement contour for a circular piled Raft for the load of 8.1 kN

Figure 12 presents the comparison of the load settlement response obtained from the 1g model tests and the non-linear 3D analyses. It can be seen that the agreement is far better when compared with the axisymmetric analyses. The variation at the higher loading was found to be of the order of 5% only. The comparison of the characterised response given in Figure 13 confirms that the three dimensional analyses presents closer response to the actual behaviour obtained from the 1g tests. Therefore the results can be used to predict the raft stress and the pile shaft stress distribution.

Figure 14 presents the raft stress distribution under a loading corresponding to 2mm settlement and 17.7mm settlement at the maximum load. It can be seen that in both the cases the stress distribution is uniform; at 2mm settlement the contact stress was found to vary from 0.02N/mm^2 to 0.4 N/mm^2. From this it can be computed that the load shared by the raft was of the order of 35% of the applied load at the final settlement level the raft stress varied from 0.162 N/mm^2 to 0.169 N/mm^2.The load shared by the raft at this level was found to be 64% of the final load.

Figure 15 and Figure 16 represents the pile head stress and the tip stress at the maximum. It can be seen that the pile head stress increases with the load. The tip stress is very small and the increase in the tip stress is not in proportion with the load applied. The ratio of the head stress to the tip stress is of the order of 11%, 9% to 10% and 17% to 19% in the central, the inner ring and the outer ring of piles respectively.

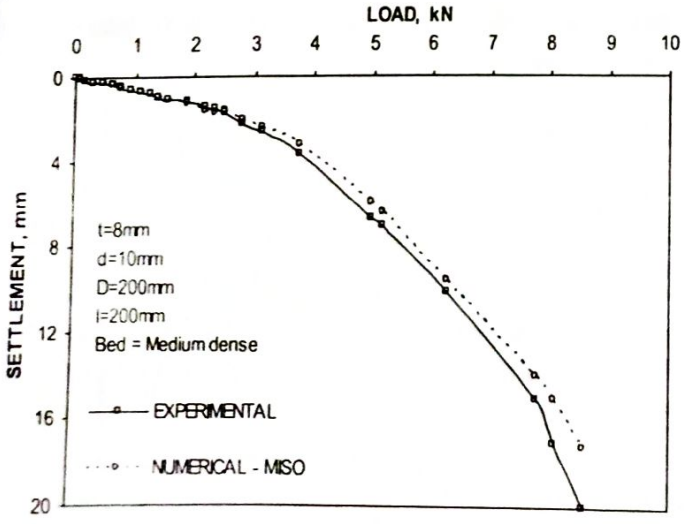


Figure 12 Comparison of load-settlement behaviour between ANSYS and model test data (Circular Raft)

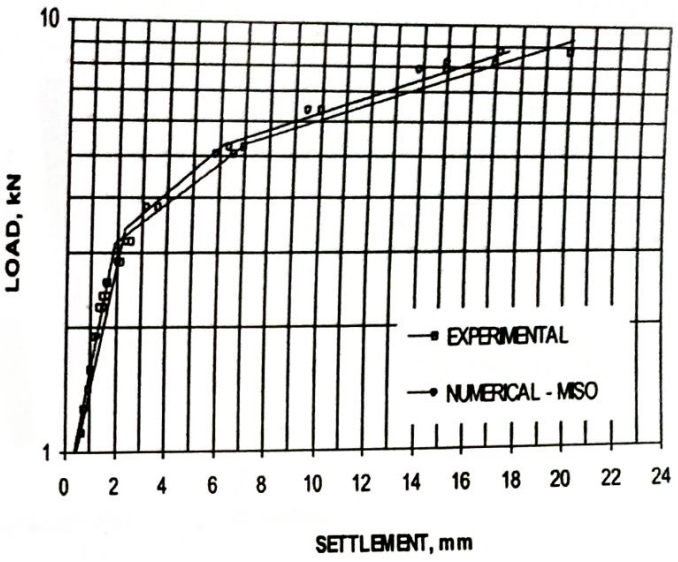


Figure 13 Characterization curves for experimental and numerical 3D Circular

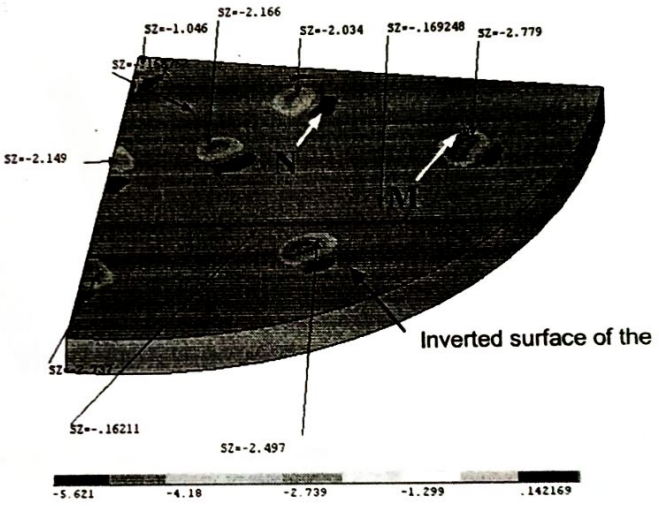


Figure 14 Vertical stress at typical locations of the raft for the load of 8.10 kN (settlement = 17.80mm)

Figure 17(a) indicates the shaft stress distribution and the variation in the shaft stress distribution also follows a similar trend. It is seen that the shaft stress reduces to a negligible value beyond a length of 0.8L which can be termed as critical length as predicted by Vesic (1969). A similar trend was seen in the case of square raft also as in Figure 17(b), establishing the ductile nature of the pile group.

It can be concluded that while the axisymmetric analyses and plane strain model could predict the load settlement response the load sharing response could not predict a reliable manner due to the stiffer load settlement response. On the other hand the three dimensional analyses could bring out not only the load settlement behaviour in a realistic manner but also the load sharing behaviour and the individual pile stress establishing the ductile behaviour of the pile group. Hence it can be concluded that the initial analyses for the preliminary designs for establishing the pile layout, length and the diameter needed to obtain the settlement reduction achievable and once this is done the layout and data can be used for the detailed analyses.

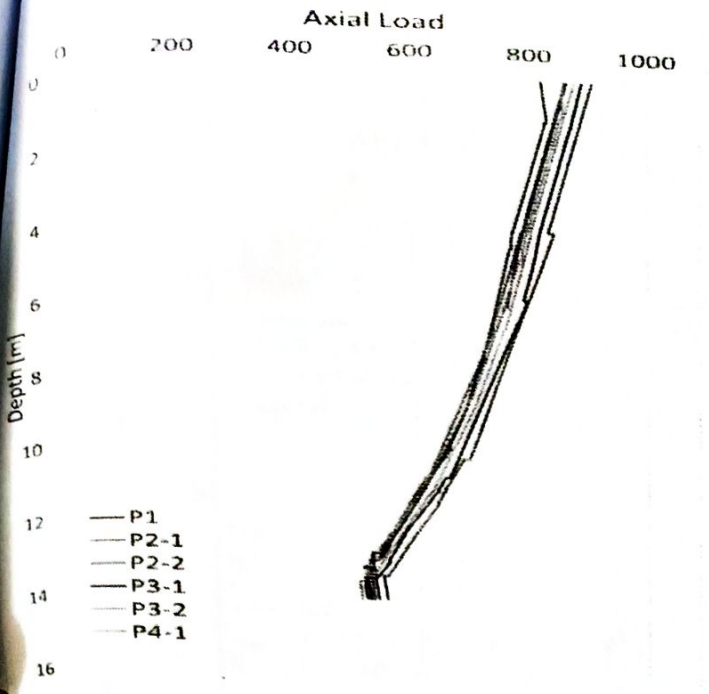


Figure 24 Pile Shaft Stress Distribution

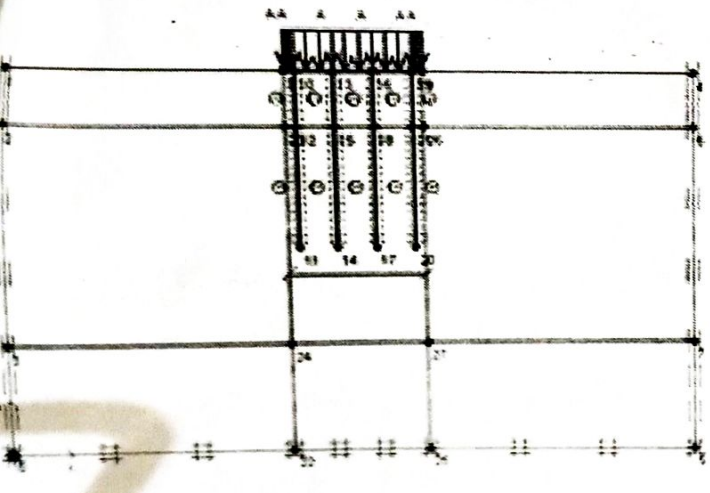


Figure 25 PLAXIS model for Pier

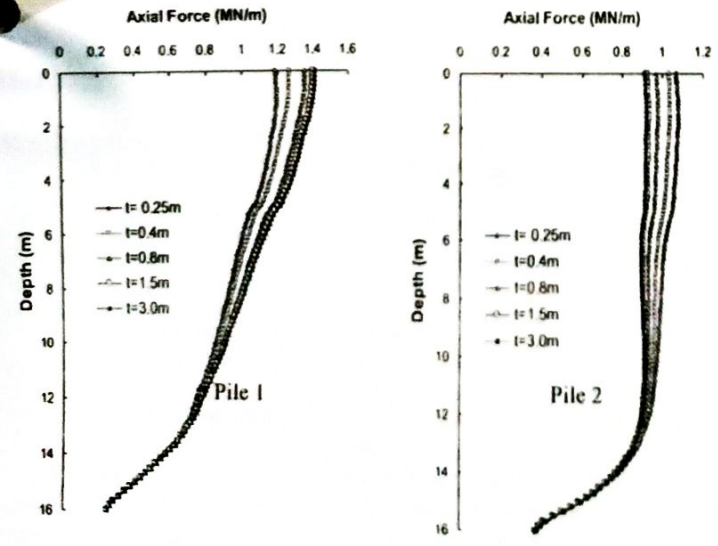


Figure 26 Effect of Raft Thickness on Pile Axial Force

7. CONCEPT OF EQUIVALENT PIER

The concept of equivalent pier was proposed by Poulos (1973) for evaluating the pile group settlement. The advantage of applying this concept to Piled raft is that the analyses can be done adopting two dimensional axisymmetric idealization to evaluate the settlement of the pile draft.

In order to establish the applicability of equivalent pier approach the pile group under the maximum loaded coloumn in the grid G13 along with its tributary area of the raft (6m dia) was modeled using PLAXIS 2D (Balakumar etal., 2013). The pier and the soil data are presented with the model in Figure 27 (a) and (b). The settlement at the maximum load was 12mm against 14mm showing a fair agreement between the observed and predicted value.

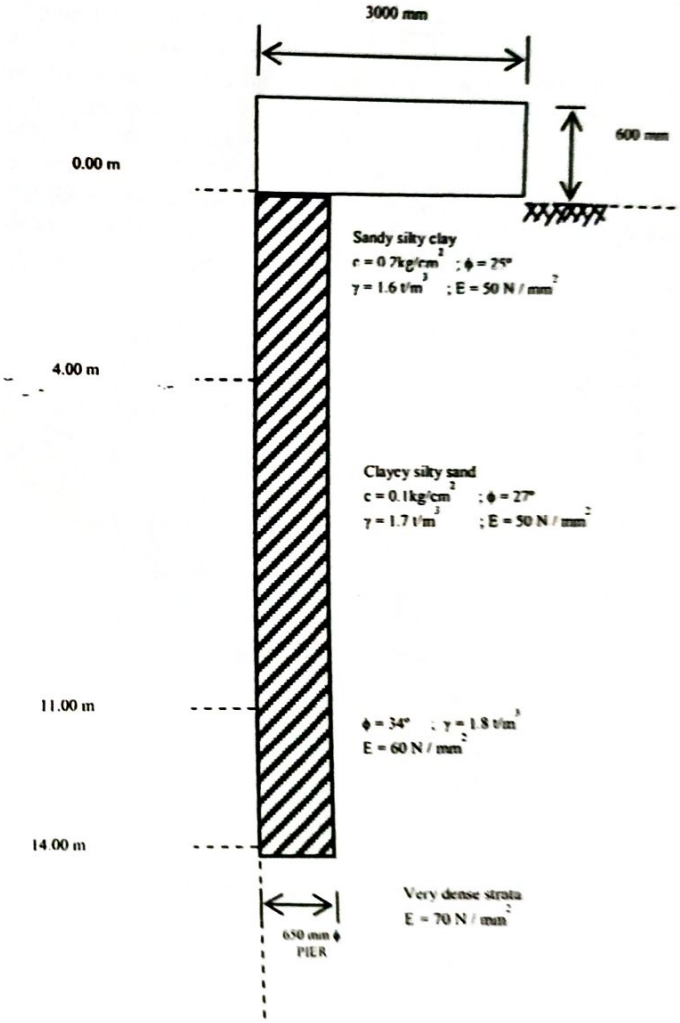


Figure 27(a) Observational study G 13 Pile group model

The second model shown in Figure 28 was a hypothetical model studied by Min Huang (2006) which has 16 piles and a parametric study was conducted by varying the pier length. Figure 29 indicates pier model and Figure 30 presents the shaft stress distribution obtained from the analyses The shaft stress distribution shows an increase in the stress from 12m level onwards upto 16m. It was seen that the layer between 13m to 16 m is a compressible peat layer. Probably it has caused an increase in the load due to the negative friction mobilized. Thus a simple axisymmetric analysis could bring out adequate details required for the detailed design.

For comparison the shaft stress distribution obtained by Min Huang (2006) is also presented for comparison, along with the model. The entire analyses was done with PLAXIS 2D. Both these curves are compared with the shaft stress distribution obtained from the model studies presented in Figure 28.

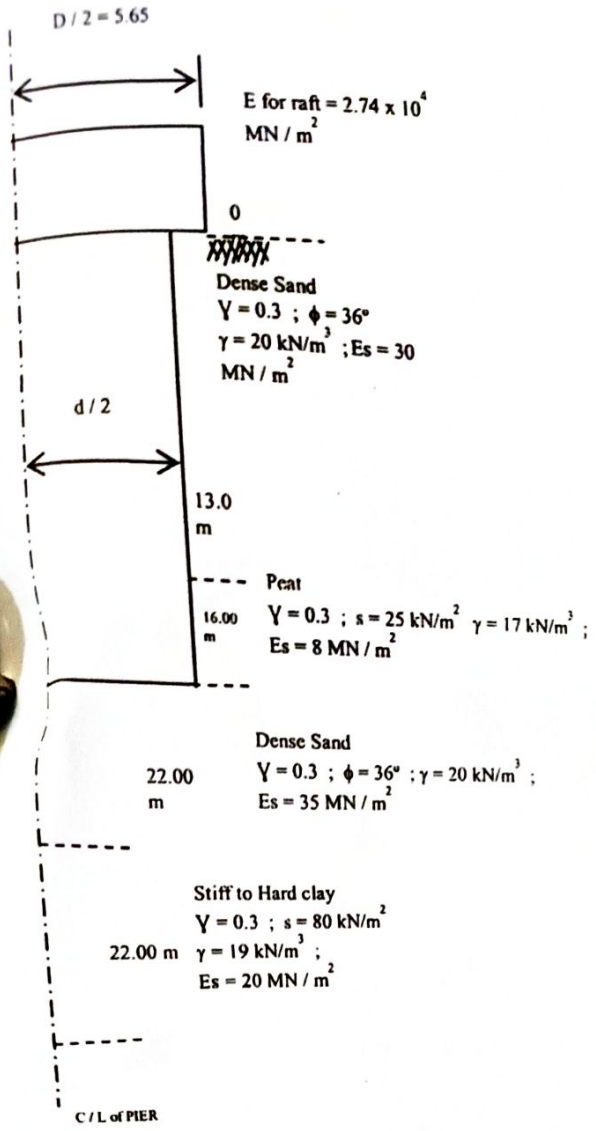


Figure 27(b) Pier & Geotechnical Data Hypothetical Problem

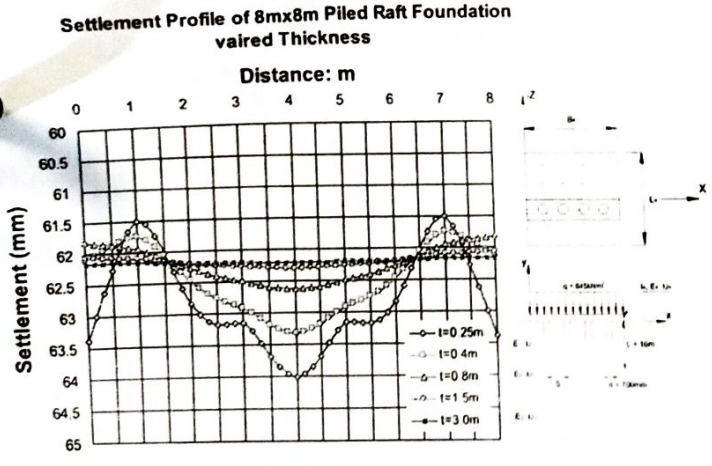


Figure 28 Diagrammatic view of boundary condition using for modeling

It is seen that the trend is identical irrespective of the software used and bed material and the pile group configuration. The ratio between the head stress and the tip stress was obtained from the various methods falls within a close spectrum.

8. DISCUSSION

From the above extensive study it is seen that the type of software appears to have no influence on the results Obtained from the analytical study. However the two dimensional analyses based on axisymmetric idealization and plane strain model predict a relatively higher stiffness compared to what the 1g model tests had shown. This is perhaps due the fact that equivalent modulus did not take the properties of the soil prism Because of this stress distribution on the pile may not be realistic. However the settlement for the given configuration of the pile group could be predicted within an acceptable le level of accuracy. The plate on pile approach with PLAXIS could predict not only the settlement but also the shaft stress distribution on the pile and raft contact pressure for the initial requirement. With all the details and parameters validated the detailed three dimensional analyses can be taken up for the final design. As a matter of comparison the shaft stress distribution obtained from the 1g model tests on a circular piled raft ,square piled raft of identical pile raft area ratio (the ratio of sum of the areas of piles provided to the area of the raft), the shaft stress distribution from the plate on piles theory and the hypothetical model presented present in the previous sections are all identical. Further the ratio of pile head stress to tip stress obtained from the analyses using ANSYS and the plate on piles idealization analyzed using PLAXIS are in a reasonable level of agreement indicating that depending on the data required two dimensional analyses or a simple concept like plate on piles or equivalent pier theory can be adopted before embarking on detailed three dimensional analyses.

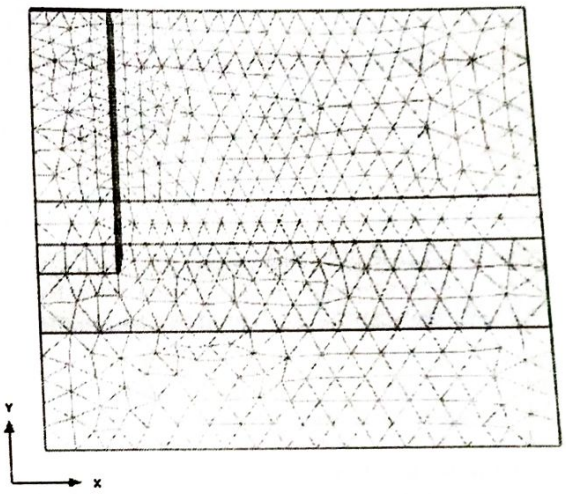


Figure 29 Typical Mesh PLAXIS 2D

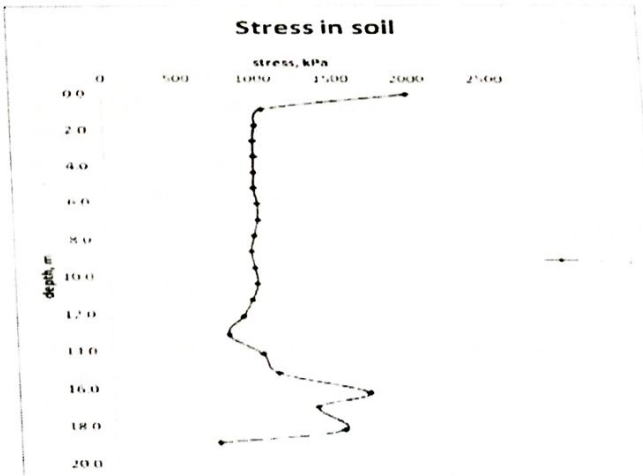


Figure 30 Shaft Stress Mobilisation (18m Deep Pile)

9. CONCLUSION

The present study has established the load transfer and failure mechanism of the piled raft through 1g model tests. The available

esults of three typical cases of piled raft namely a small scale 1g model, a real time piled raft supporting a basement plus twelve storied structure and a hypothetical piled raft resting on a generalized soil profile obtained from Gold Coast area were all studied with two different software namely ANSYS and PLAXIS both of them being finite element based and the results were compared. It is observed that:

The axisymmetric and plane strain model is found to be very convenient to study the load settlement response of the piled raft under consideration. Both the models are user friendly and number of repetitions can be made to finalize the parameters numerations requirements.

10. ACKNOWLEDGEMENT

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11. REFERENCES

Balakumar V. Kalaiarasi V. and Ilamparuthi K. (2005) "Experimental and Analytical Study on The Behaviour of Circular Piled Raft on Sand", Proc. 16th International Conference on Soil Mechanics and Geotechnical Engineering-2005, Osaka, Japan.

Balakumar V and Ilamparuthi K. (2007) "Performance Monitoring of a Piled Raft Foundation of Twelve Storied Building and Analytical Validation", Indian geotechnical Journal, Vol. 37, No. 2, pp. 94-115.

Balakumar V (2008) "Experimental Studies of Model Piled Raft on Sand and Field Study of Prototype Behavior",PhD. Thesis, Anna University, Chennai.

Balakumar V. and Ilamparuthi K. (2008) "Behaviour of Rectangular Piled Raft and the Numerical Validation", Indian Geotechnical Conference, 2008 – Bangalore, India, pp.

Balakumar V. and Ilamparuthi K. (2010) "Experimental and Numerical study on the behaviour of pile group of piled raft", 17th South East Asian Geotechnical.

Balakumar V. and Ilamparuthi K. (2010) "Experimental and Numerical study on the behaviour of pile group of piled raft", 17th South East Asian Geotechnical Conference 2010, Taipei, Thailand, pp. 200-203.

Balakumar V. Min Huang Erwin Oh, Mark Bolton and A.S.Balasubramaniam (2013) "Limiting Capacity of Piled Raft", 18th South East Asian Geotechnical and Inaugural AGSSEA Conference 2013, Singapore, pp.

Balakumar V. Min Huang Erwin Oh, Mark Bolton and A.S.Balasubramaniam (2013), "Limiting Capacity of Piled Raft", 18th South East Asian Geotechnical and Inaugural AGSSEA Conference 2013, Singapore, pp.

Burland J.B. (1995) "Piles as Settlement Reducer", 18th Italian Congress on Soil Mech., Pavia.

Burland J.B., Broms B.B. and de Mello V.F.B. (1977) "Behaviour of Foundations and Structures", Proc. 9 ICSMFE Tokyo 2, pp. 495 – 546.

Desai C.S., Johnson L.D. and Hergett (1974) "Analysis of Pile Supp.orted Gravity Lock", Jnl. Geotech. Engg., Vol. 100, No. 9, pp. 1009-1029.

Hooper J.A. (1974) "Observations on the Behavior of a Piled Raft Foundation on London Clay", Proc. Institution of Civil Engineers, Part 2, Vol. 55, pp. 855-877.

Horikoshi K. (1995) "Optimum Design of Piled Raft Foundations", Dissertation submitted for the degree of Doctor of Philosophy, University of Western Australia.

Katzenbach R., Arslan V. and Moorman ch (2000a) "Numerical Stimulations of Combined Piled Raft Foundations for the New High Rise Building", Max in Frankfurt am main, Proc. 2nd Int. Conf. on Soil Structure Interaction in Urban Civil Engineering.

Min Huang. M (2006) "Rafts and Piled Raft foundations at Surfers Paradise Gold Coast, Australia – Analytical study using PLAXIS Software" – A theses submitted in Partial Fulfilment partial requirement of the degree of Master of Civil Engineering from Griffith University Gold Coast campus Australia.

Murray E.J. and Geddes J.D. (1989) "Resistance of Passive Inclined Anchors in Cohesionless Medium", Geotechnique, Vol. 39, No. 3, pp. 417-43.

Poulos H.G. (1989) "Pile Behaviour – Theory and Applications", Geotechnique, Vol. 39, No. 3, pp. 365 - 415.

Poulos H.G. (2001) "Piled Raft Foundation: Design and Application", Geotechnique, Vol. 51, No. 2, pp 111-113.

Polous H.G. (2008) "The Piled Raft Foundation for the Burj Dubai – Design & Performance", IGS – Ferroco Terzaghi, Oration – 2008

Prokoso W.A. and Kulhawy F.H. (2001) "Contribution of Piled Raft Foundation", Journal of Geotechnical and Geoenvironmental Engineering, ASCE, pp. 17 24

Reul O. and Randolph M.F. (2002) "Study on the Influence of Finite Element Mesh Refinement on the Calculated Behavior of Piled Raft", Proc. of 8th Int. Symp. Numer. Models. Geomech Rome, pp.259-264.

Roger Franke, Nicholos Kateziotis , Michel Bustamante, Stavaros Christoulos (1991) "Evaluation of Performance of Two piles Using Pressuremeter Methods", Journal of Geotechnical Engineering, Vol 117,no.5 May 1991 ASCE pp 695-713

Russo G. (1998) "Numerical Analyses of Piled Rafts", Intl. Jnl. Num. and Anl. Methods in Geomech, Vol. 22, pp. 477-493.

Turek J. and Katzenbach R. (2003), "Small Scale Model Tests with Combined Piled Raft Foundations", Proceedings of the 4th International Seminar on Deep foundations on Bored and Augured piles, Ghent, Belgium, pp. 409-413.

Vesic A.S. (1969) "Experiments with Pile Groups on Sand - Performance of Deep Foundations", ASTM, STP, 444, pp.177-222.

Weisner T.J. and Brown P.T. (1978) "Laboratory Tests on Model Piled Raft Foundations", Research Report 318, Sydney University.

Yamashita K., Kakurai M. and Yamada T. (1994) "Investigation of a Piled Raft Foundation on Stiff Clay", Proc. of 13th International Conference on Soil Mechanics and Foundation Engineering, New Delhi, pp. 543-546.

Yamashita.K, Hamada.J, Yamada.T. (2010) "Field Measurements on Piled Rafts with Grid-Form Deep Mixing Walls on Soft Ground", Geaotechnical Engineering-SEAGS Vol.42 No 2 June 2011.

RIVER TRAINING –A CASE STUDY

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Abstract—**The Vellar river basin is located in the Northern part of Tamil Nadu State in South India, between the latitudes 110 13' N – 120 00' N and longitudes 780 13' E – 790 47' E. The total area of the basin is 7520.87 Sq. Km. The total length of the river is about 150 km. The river originates on the southern slope of Kalvarayan hills in Salem District and drains into Bay of Bengal near Parangipettai (Port-O-Nova) in Chidambaram taluk of Cuddalore District. The river is a seasonal one and receives most of the flow during north east monsoon. In the lower reaches the river is experiencing heavy meandering resulting loss of agricultural lands and roads located adjacent to the banks. Initial field surveys were conducted for prevailing field information. Using the data, HECRAS-1D and Mike 21 numerical modeling studies were performed. Based on the studies vulnerable locations were identified and initial river training works were designed and experimentally verified through physical modeling techniques and finalized. The post effects of the training works are observed which resulted in good accretion The details of numerical and physical model studies along with post project effect of training works are detailed in the paper.**

Keywords—Basin; Erosion; Spur;

I. INTRODUCTION

Vellar river originates in the Kalrayan hills of Salem district in the reserve forest area at of Salem in Salem District and drains into Bay of Bengal near Parangipettai (Port-O-Nova) in Chidambaram taluk of Cuddalore District.The Vellar river basin is located in the Northern part of Tamil Nadu State in South India, between the latitudes 11^0 13' N – 12^0 00' N and longitudes 78^0 13' E – 79^0 47' E. The total area of the basin is 7520.87 Sq. Km. The total length of the river is about 150 km (Fig 1). The river Vellar is having six tributaries. In the lower plain river takes meandering course. T (Fig 2)he Vellar system is a well known irrigation system of the district where agricultural activity is in full swing. During the flash floods of north east monsoon the river causes very heavy erosions resulting heavy damages to cultivable lands and bridges. Hence, the affected people represented to the Government to safeguard their villages from the damages, dwellings units, agricultural land, live stocks and their properties by forming flood banks, construction of spurs and retaining walls. The government of India has also sanctioned the schemes under flood management program for rehabilitating flood banks, construction of spurs and retaining walls. The total area of the basin is 7520.87 Sq. Km. The total length of the river is about 150 km (Fig 2). The lower meandering reach of river for a length of about 80km is in Cuddalore district. The average rainfall of the district is 134cm. Nearly 70% of rainfall is during north east monsoon. During the flash floods of north east monsoon the river causes very heavy erosion at locations where river is meandering resulting heavy damages to cultivable lands and bridges (Fig 3). TV Puthur is one such agriculture village located along the meandering stretch which has undergone heavy damage resulting erosion of agriculture land. The area is active in agriculture and hence necessary representations were made by the locals for suitable protection works. Subsequently the project proposals were made and protection works were sanctioned under flood management program of Government of India.

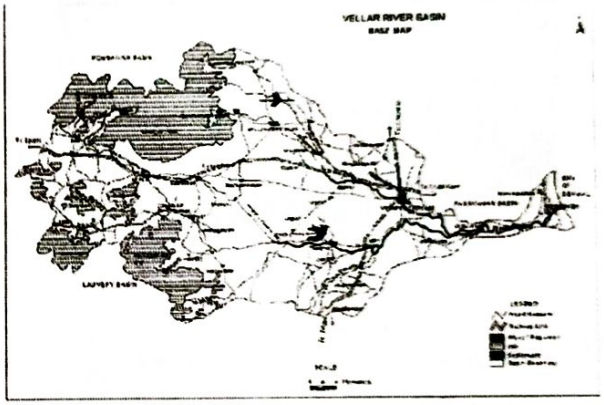

Fig 1Index map

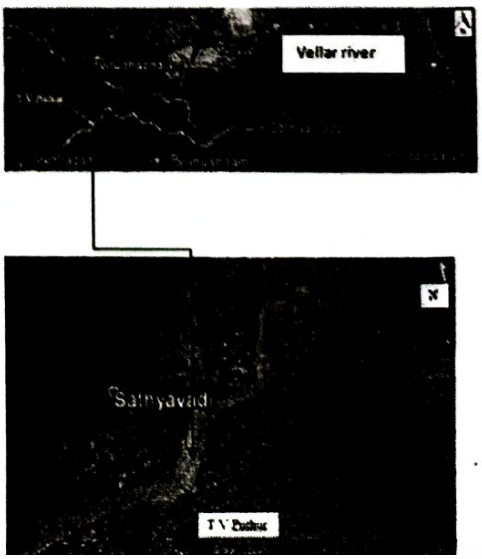

Fig 3 Erosion of agriculture land

II. METHODOLOGY

Field visit was made and initial site investigations and rainfall data analyses were carried out. With the available data was decided to use various modelling approach. In the present situation one dimensional modelling, two dimensional modelling and physical modelling studies were carried out. The details of rainfall are given vide Fig 4. The rainfall data is grouped as Non Monsoon (NM) from January to May, South West (SW) from June to September and North East (NE) during October to December. The annual normal rainfall for the period (2001- 2011) ranges from 1050 – 1400 mm. The normal annual rainfall over the district varies from about 1050 mm.The contributions of individual seasons are as follows: NE-57%, SW-31%, Summer - 7% and winter 5%.But the rainfall pattern in third decade shows high magnitudes of north east monsoon.

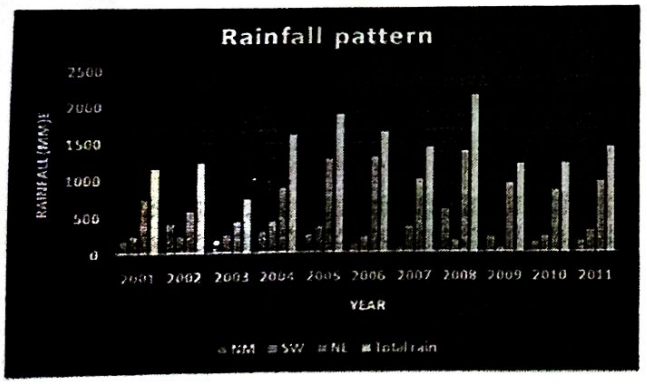

Fig 4 Rainfall details

III. HECRAS MODEL RUN

In order to assess the existing hydraulic conditions of the field, numerical model studies were made. For the present study the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) software is used. This software is developed by the Hydrologic Engineering Center (HEC - 2008), which is a division of the Institute for Water Resources (IWR), U.S. Army Corps of Engineers. HEC-RAS allows users to perform one-dimensional steady and unsteady flow calculations (HEC, 2002). In a HEC-RAS steady state simulation, water surface profiles are computed from one cross-section to the next by solving the standard step iterative procedure to solve the energy equation. The energy equation is intended to calculate water surface profiles for steady gradually varied flow.The input are geometric, flow and boundary data. The geometric data consisting of cross section and chainages were keyed in after making a base map of the study area. The flow data adopted was the maximum value as suggested by the field engineers. The upstream and downstream slopes were given as boundary conditions.

With the above flow data and the boundary conditions, results are obtained by running the HEC-RAS model for different scenarios. The results of the same are obtained for the steady state flow conditions. The maximum value of discharge of 3596 cumecs was adopted. The results of HECRAS study indicate that there is a need to redesign the existing banks since the waterway is insufficient for the design discharge resulting in bank overflow. Cross section is for every 30m over a length of 750m. The details of the cross section and results of HECRAS run for one of the cross sections are detailed vide Fig 5.

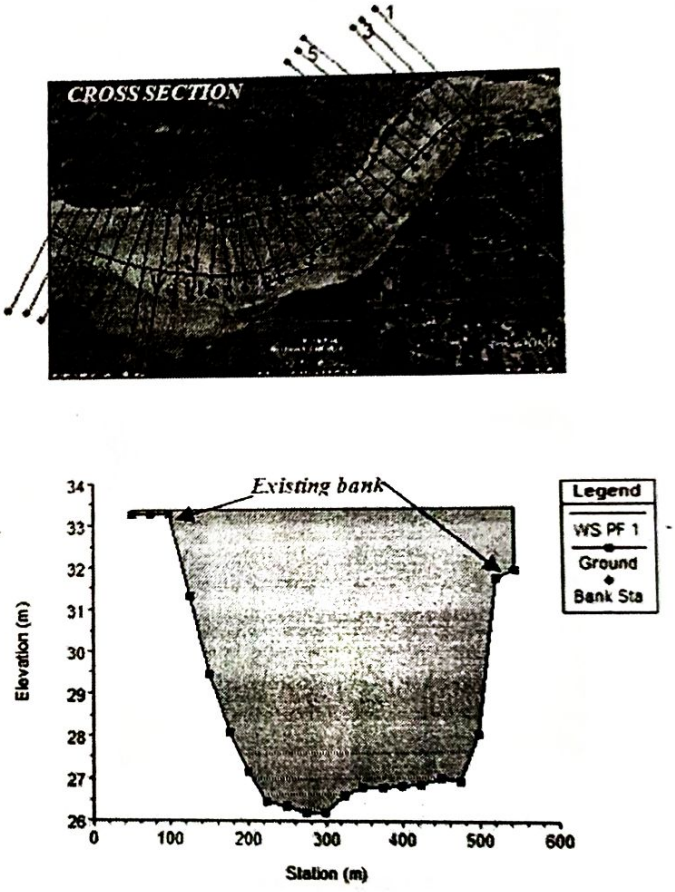

Fig 5 HECRAS Water surface profile.

IV. MIKE21 MODEL RUN

MIKE 21 HD is the basic computational hydrodynamic module of the entire MIKE 21 system (DHI 2001) providing the hydrodynamic basis for other MIKE 21 modules. The

avier-Stokes equations. The model consists of continuity, momentum, temperature, salinity and density equations and it is closed by a turbulent closure scheme. The input to the model is hydrographic details of river, discharges at the open boundaries. The output includes velocity contours and water levels...The river bed contours are detailed in Fig 6 and 7. this is used as input for Mike21 software. The study indicate eddy formation with high velocity on the right side bank. It was proposed to strengthen the river banks by providing spurs.Then the studies were performed with spurs on the right side of bank and then flow pattern observations with spurs placed at locations suggested by field engineers were studied. The lengths are adopted as discussed in Technical report of CBIP (1971, 1987). The spurs with an angle of 22^0 from normal to the bank of 30m length facing upstream found to be effective in reducing velocity adjacent to right bank

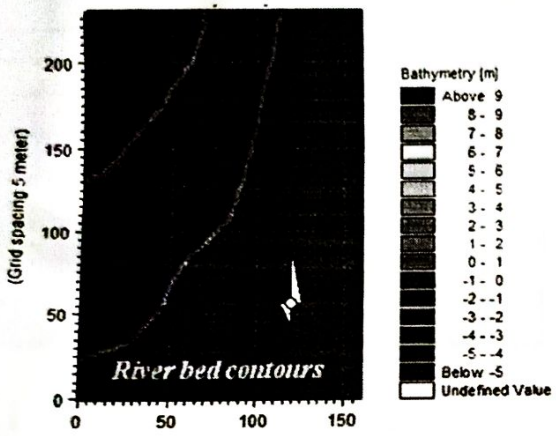

Fig 6 River bed contours

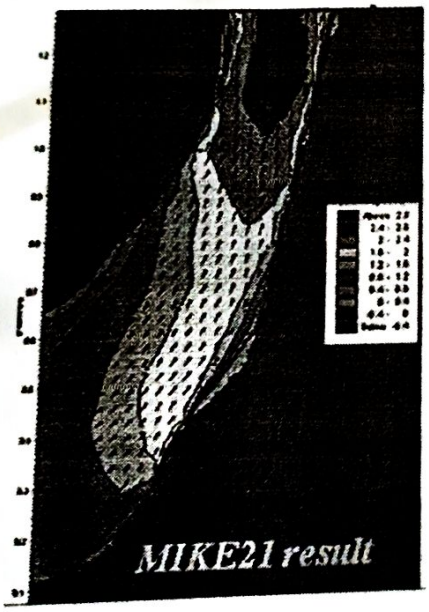

Fig 7 Model run

V. PHYSICAL MODEL STUDIES

Physical model studies were carried out to study the performance of river training spurs proposed from Mike21 model studies and top level of the banks were revised based on HECRAS model studies with a free board of 1.80m. A comprehensive mobile bed, geometrically distorted physical river model, with a horizontal scale of 1:500 and vertical scale of 1:100, and the representing affected site of Vellar River at TV Puthur with the proposed spur location was constructed. Model discharge of the river was allowed through 'V' notch. Necessary gauge wells have been constructed for measuring the water levels as done for other reaches of Vellar (IHH Poondi-1995). In the model, bed of the river has been properly simulated. The effective size of the sand particles were arrived based the tractive force in the field. From this, utilizing the roughness index, model sediment size was calculated based on Shield stress criteria and found to be 0.6 mm. Accordingly corresponding mesh was utilized to get the 0.6 mm diameter sand materials. The mobile bed was formed utilizing the above sieved sand particles. The completed model is shown in Fig. 8 to 10.

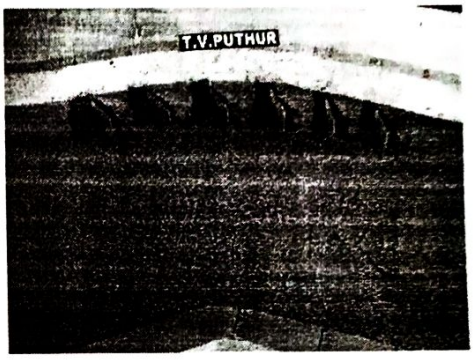

Fig 8 Dry model

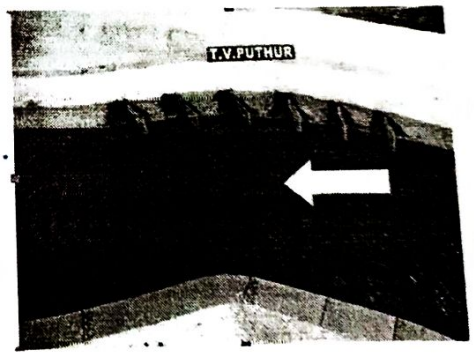

Fig 9 Running model

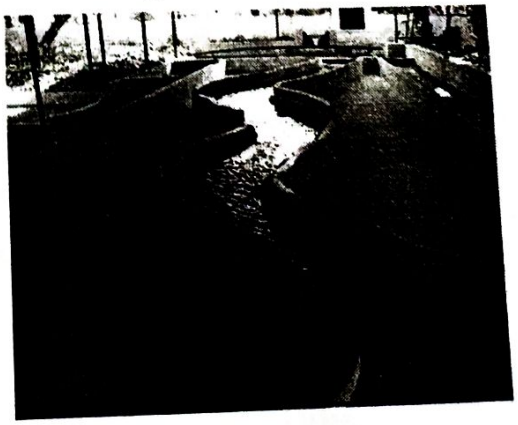

Fig 10 Complete view of model

VI. REMEDIAL MEASURES

Initial proposal of rehabilitating the existing bank level was proposed based on numerical model studies. The final geometry of spur layout was arrived after performing physical model studies (Table 1).The remedial measures proposed are in the form of revised bund level and repelling spurs The bund level and location of the spurs as finalized are tabulated below. The length of groin is of 30m length . The orientation angle is 25^0 from normal to the bank facing upstream side. .

TABLE I.

Sl no	River Training Spurs		
	Chainage(m)	*Level (m)*	*Spur no*
1	42910	35.270	G1
2	43020	35.200	G2
3	43120	35.100	G3
4	43210	35.070	G4
5	43320	34.970	G5
6	43410	34.870	G6

VII. FIELD IMPLEMENTATION

The remedial measures based on the model studies were implemented by 2013. The bund of the rehabilitated. The spur layout was also implemented as per numerical and physical model study. Initially the river has undergone erosion of about 50m for a length of 750m. The field observation were done in 2016 and also using satellite imagery. The observations indicate good accretion of about 20m adjacent to the spurs. The existing paddy fields are free from threat of erosion. The details are furnished vide Fig 11 to 14.

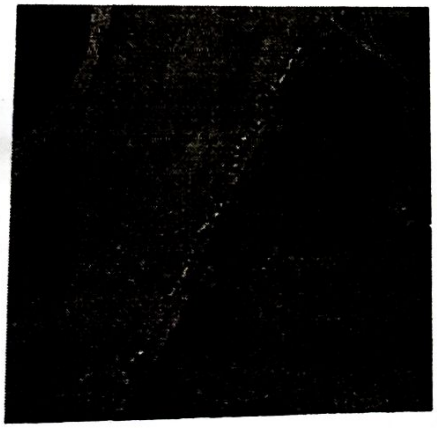

Fig 11 Eroded stretch (Pre project)

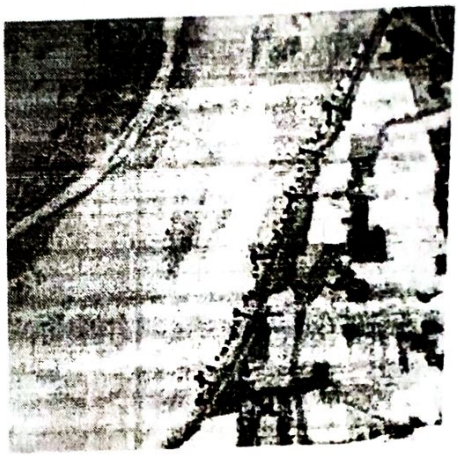

Fig 12 Protection works (Post project)

Fig 13 Sand formations between spurs after project

Fig 14 Protected agriculture activities

VIII. RESULTS AND DISCUSSION

Vellar is a seasonal river and flows only during north east monsoon. The catchment receives heavy to very heavy rainfall during this. The river flows with very heavy discharge for a few days. During this period it river brings enormous sand. Due to uneven terrain it undergoes heavy meandering resulting in loss of valuable agriculture lands. Hence the studies were conducted both by numerical and physical model techniques. Based on the studies spurs were finalised. The spurs provided on the Right bank deflects the flow current concentrate to the central portion of the river. Eddy formations observed near the toe of the spurs, for which suitable toe protection is to be provided to avoid local scour. Slight

protection. The trial model photos of the TV Puthur is wn vide (Fig 11 to 14). As a part of model proto nformity, field observations were done in 2016. The studies dicate good sand deposition in between spurs thus strengthening banks.

IX. CONCLUSIONS

The inferences on the model run with sufficient number of trials account to the effective functioning of the Repelling. Spurs of length 30m having an angle of 22° were provided. The performance also seemed to be satisfactory. The project was implemented after a series of comprehensive studies. The post observations have shown that the project is a successful one in protecting the banks and adjacent agricultural assets.

ACKNOWLEDGMENT

The authors acknowledge the dedicated services of gineers Balamurugan, Tilakam and Palanikumar for collection of field data and suggestions during the course of model studies.

REFERENCES

[1] Central Board of Irrigation and Power " Manual on river behavior, Control and Training" Technical Publication no 60, 1971

[2] Central Board of Irrigation and Power "report on design of Spurs" Publication no 39, 1987.

[3] Institute of hydraulics & Hydrology, Poondi Hydraulic model studies for providing protective arrangements at the right bank of river Vellar" IHH Report no 17/1995

[4] Danish Hydraulic Institute (DHI) , User Manual and Reference Guide for LITPACK and MIKE21 (2001) ,

[5] US Army corps of engineers Hydrologic Engineering Center HEC-RAS River Analysis System Application guide March 2008S

MIGRATION OF CHILIKA LAKE MOUTH

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ABSTRACT

Chilika lake is the largest lagoon along the east coast of Indian state Odisha, situated between latitude 19° 28' and 19° 54' N and longitude 85° 05' and 85° 38' E. The place is known for rich biodiversity and is the largest wintering ground of migratory bird and largest population of Irrawaddy dolphin, habited by migratory birds and by a special type of dolphins. The highly productive ecosystem of the lake is support the livelihood for fishermen and also acts as drainage for Mahanadhi river basin. The estuary is very sensitive to the sediment dynamics. The closure of estuary mouth or shifting of Chilika Lake mouths tremendously changes salinity and ecology of the lake system. The east coast of India along this coast is having a net alongshore drift of about 0.7 $X10^6$ m^3 annually towards north direction. The inlets of Chilika lake are under the influence of alongshore sediment transport from the coast. Apart from this the rivers bring sediments during peak south west monsoon season. Because of this the inlets are migrating, depending on the season. The details of migration of estuary opening were analyzed using satellite imageries. The analyses of watershed, coastal process and configuration of estuary are detailed in this paper.

Keywords: Chilika Lake, ecosystem, salinity, coastal process.

1 INTRODUCTION

Chilika Lagoon, the largest brackish water body of Asia, on the east coast of Odisha, India is 4000 years old (Venkatratnam 1970).The lagoon is separated from Bay of Bengal by a barrier spit shown in Figure 1, 64.3km long and connected to it by four tidal inlets of varying depth and size. All inlet activities occur on the onshore face of the lagoon. The brackish character of Chilika lagoon was deteriorated during past three decades of twentieth century. The hydrodynamic regime of the lagoon was affected during this period. Consequently the ecology, biodiversity and economy of the area were also affected. The present study deals with the variation of geometry of mouth of estuary with time. The extreme meteorological events, hydrological aspects, tidal outlet (figure 2) and coastal process involved on the closure, migration and opening of new tidal inlets in Chilika lagoon at Arkhakuda, Gabakund, and Sipakuda are discussed.

- Project Location details

Satapada and Magarmukh area of Chilika Lake are under Krushnaprasad and Brahmagiri Block under Krushnaprasad Tahasil in Puri District.

- Demographic details of the population

Total fisherman population of peripheral villages of Chilika is more than 2 lakhs. Those are directly dependent on the lake fishery for their daily livelihood.

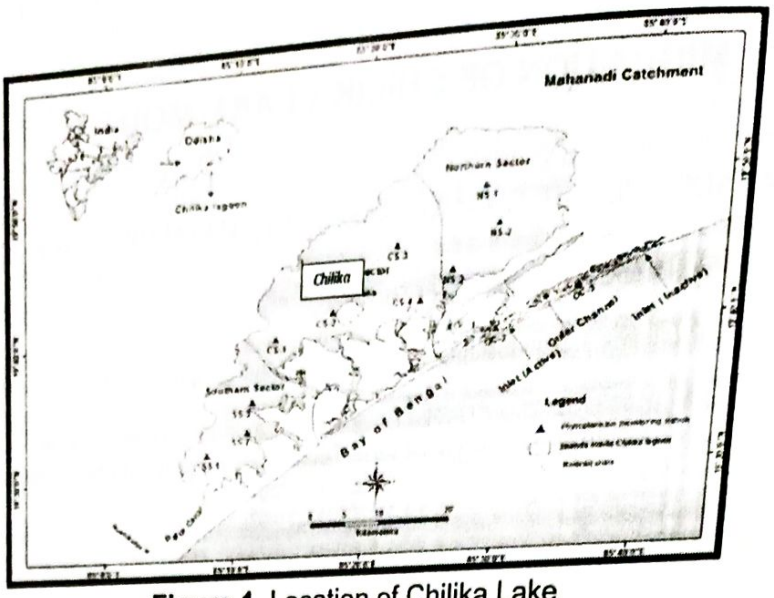


Figure 1. Location of Chilika Lake

2 GEOLOGICAL PROCESSES

Geological processes change the geomorphological landform features continuously. The study on the old topographical maps of 100 years, indicate complete change of Chilika lagoon especially along the shore. The prevailing wind erodes transports and deposits sand from one place to another. These geodynamical actions may be due to several causes. However identifying these causes, it is possible to make some sustainable development such as mouth stabilization.

3 GEOLOGICAL HISTORY

Geological studies reveal that the coastline extended along the western shores of Chilika in the Pleistocene era, and that the entire northeastern region north of Chilika was under the sea. Since then, the coastline has moved considerably eastward. Similarly, the Konark temple, built on the seashore a few hundred years ago, is now over 3 km from the coast. Most lagoons seen today were formed as a result of a worldwide rise in sea levels over the last 6,000-8,000 years. There was a pause in the rise in sea levels about 7,000 years ago. At that time a sandy beach might have formed near the coast at the Southern sector. As the sea rose further, this sand beach grew gradually. It progressed seaward and to the northeast, to form what is now the spit of Chilika. A recent fossil from the southwestern edge of the spit has been dated to about 3,500-4,000 years ago, which is some indication of how-long ago the lagoon was formed. The growth of the spit at Chilika is supposed to be due to the abrupt change in the direction of the coast north of the lake, strong winds transferring sand to the shore, longshore drift, and the presence or absence of strong river and tidal currents in different areas.

The spit of Chilika is constantly changing. The sand bar has been widening, and the position of the mouth constantly shifting, moving generally towards the northeast. The mouth was described as being about 1.5 km wide in 1780, and had decreased to half that within forty years in 1820. The mouth frequently gets choked up and has to be cut open artificially, often by the local fisher-folk, whose livelihood depends critically on maintaining an access for the sea to enter Chilika. Meanwhile the former seabed that is now Chilika is being gradually silted up by the rivers running into it, converting, and the lagoon into its present shallow state. Soran, Nairi, Pathara and other villages around the lake have had glorious navigational traditions. The ports located around Chilika Lake had played a significant role in spreading the Indian culture to other countries. However, subsequent changes in the hydrodynamic regime caused the formation of sand bars, spits and altered sedimentation pattern, which eventually caused a decline in maritime activities in the Chilika region. Odisha coast has experienced complex geological processes combined with natural factors like littoral currents, severe cyclones, storms, wave action, flood and wind since long, which has given rise to various landforms both erosion and depositional, ultimately compounding shoreline changes along with sea-level fluctuations. The opening of the Outer channel near Arkhakuda was reported during 1914 and was found ineffective in 2000. A new mouth was opened near Sipakuda in 2000. At present Arkhakuda mouth is completely closed off and the artificially opened mouth near Sipakuda is enlarged.

A constant inflow of 13 million tonnes of sediments per year due to erosion and transportation from the catchment area is choking the lake mouth. Satellite images indicate that 46 km² areas have been silted up. Restoration plan for an integrated watershed management of the lagoon with active participation of local community and non-governmental organizations on a micro watershed basis, monitoring assessment, improvement of socio-economic conditions of the local communities shared decision making, improvement of communication network, fish stock enhancement, developments of various centers are required.

4 HYDROLOGICAL NETWORK

Chilika is influenced mainly by the tributaries of Mahanadhi River namely, the Mahanadi river delta and minor rivers flowing in the lagoon from the catchment and the tidal outlet to the Bay of Bengal which is shown

structures upstream in the Mahanadi has altered the flow pattern into Chilika. The southern distributaries, Daya and Bhargovi in Mahanadi delta join the sea via Chilika lagoon. The abnormal rainfall has caused high floods during 2001, 2003, 2006, 2008, 2011 and 2014. Year 2000 was the minimum discharge year of the millennium. Chilika Lagoon, largest in Asia receives 61% of inland flow from Mahanadi system. As per studies of Mishra and Jena (2015) major inflow to Chilika (60%) is from Mahanadi system. The number of rivers/rivulets draining into the lake is 52 and the catchment area is 3729square km.

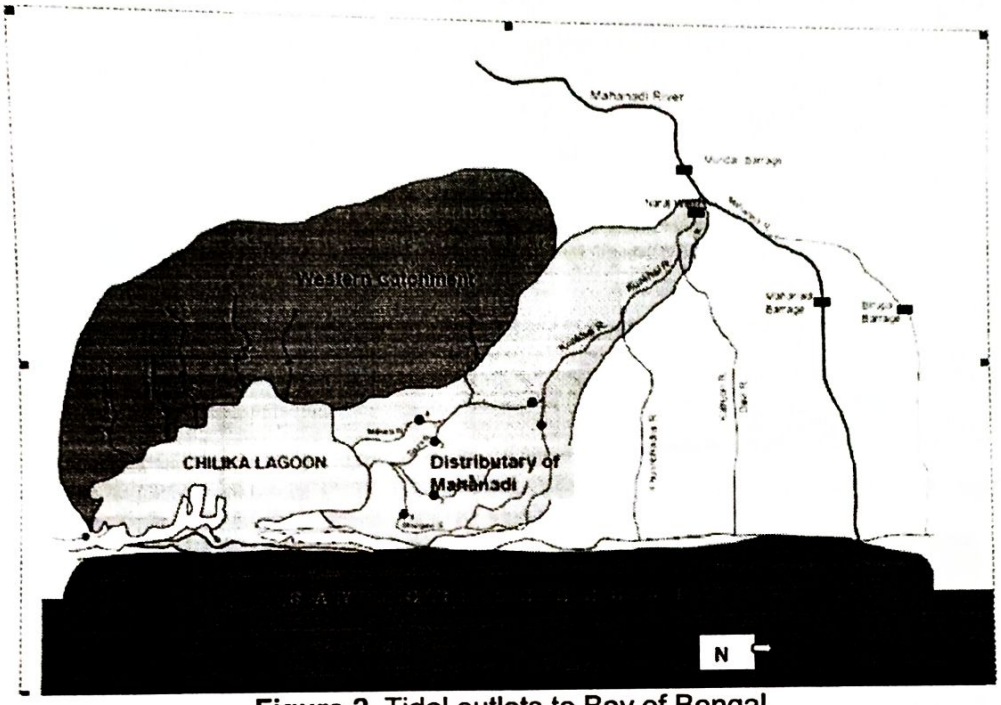


Figure 2. Tidal outlets to Bay of Bengal

5 STUDIES USING SATELLITE IMAGERIES

Preliminary studies were conducted on the migration of inlet of estuary adopting satellite imageries from Google earth is shown in Figures 3, Figure 4 and Figure 5. The Chilika lake mouth located originally near Sipakuda in 1800 has gradually shifted in the last 200 years towards the northern side to Arkhakuda. The sedimentation in the South and erosion in the North due to littoral drift is the major cause of continuous shift of the mouth towards North. The outer inlet channel of 18km length was formed between Sipakuda and Arkhakuda and the tidal exchange through this channel was not sufficient to maintain the quality of brackish water and overall brackish ecosystem of in the Chilka Lake. Because of low tidal prism, an intervention was made by cut opening a mouth of width 200m near Sipakuda in September 2000 by the Chilka Development Authority, CDA based on the numerical model study by CWPRS Pune and implementation methodology by IIT Madras. The opening of the new mouth at Sipakuda in the year 2000 improved the tidal & salinity flux to desired level in 2001. The satellite images of the mouths along the coasts in the years 1990 and 2000 are shown below.

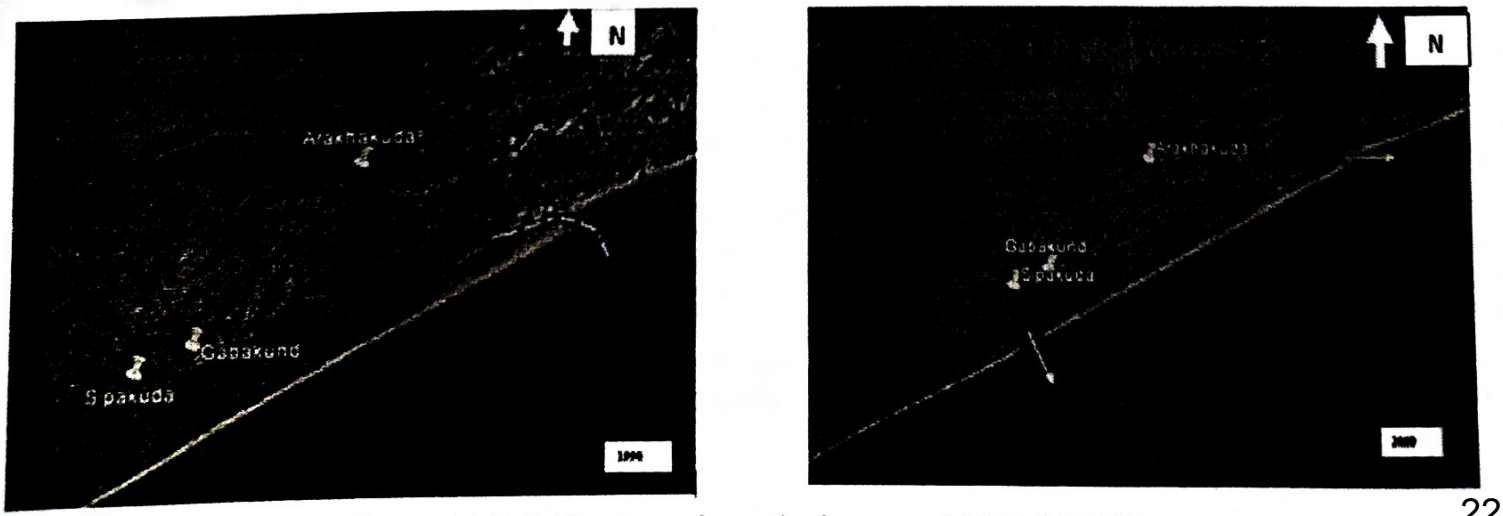


Figure 3. Satellite view of mouths in year of 1990 & 2000

role in widening of the mouth. Due to erosion of the spit on the north of Sipakuda mouth due to less supply of sediment and cyclone, another mouth was opened in August 2008, opposite to Gabakund at a distance of 1900m from Sipakuda on the day of lunar eclipse.

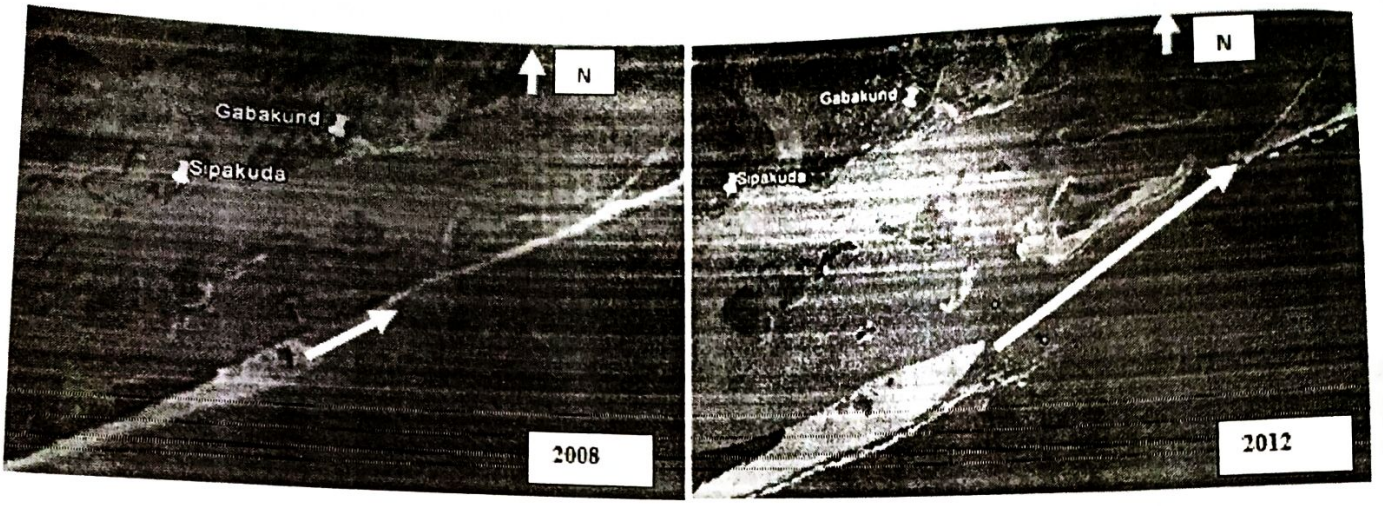


Figure 4. Satellite view of mouths (extension) in year of 2008 & 2012

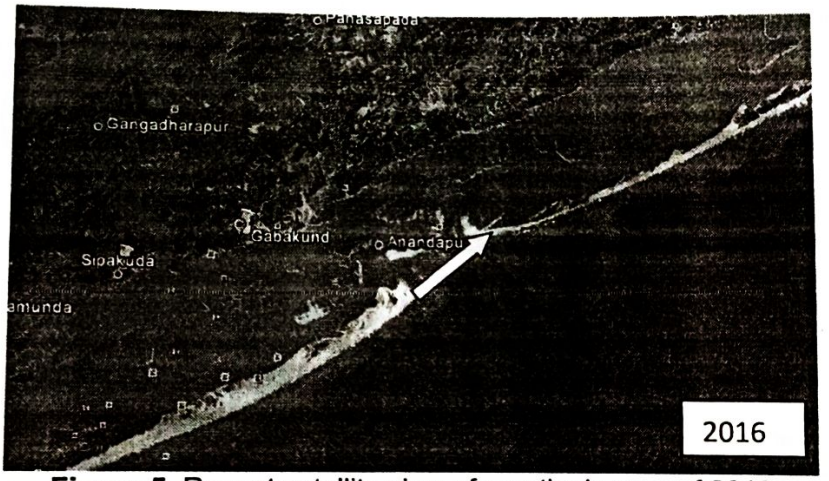


Figure 5. Recent satellite view of mouths in year of 2016

The Sipakuda mouth was consistently migrating towards north. The shifting of mouth is marginal and is only 300m from 2000-2004. But from 2004 to 2016, the mouth has migrated by 3800m with an average movement of about 300 m per year. In the process of migration, the Sipakuda mouth merged with Gabakund mouth in 2012 and the width was about 2700 m at the time of merging. However the mouth opened at Sipakuda location has gradually closed and the Gabakund mouth stabilized with reduced width.

Again in September 2012, a new mouth got opened by nature due to erosion of the northern spit, opposite to 'Dhalabali'. Now the Chilika lake has two mouths viz, i) Gabakund mouth on the southern side and ii) Dhalabali mouth on the northern side of Gabakund mouth. The approximate distance between the centers of two mouths is around 2250 m. The length of the sand spit in between these two mouths is around 1850 m. The Gabakund mouth has the width of 800 m where as the Dhalabali mouth has the width of 300m. Both Gabakund mouth and Dhalabali mouth are branching out into two major channels. The Gabakund mouth main channel leads towards main lake i.e. towards south heading Satpada, whereas the Dhalabali mouth main channel leads towards north heading to Arkhakuda. The depth remains very shallow showing less than 1.6 m w.r.t. MSL in Dhalabali mouth. Gabakund mouth remains deeper than Dhalabali mouth with a maximum depth of 3.7 m w.r.t. MSL. Similarly, the quantity of flow through Gabakund mouth is very much higher compared to Dhalabali mouth and the required tidal prism is maintained.

6 COASTAL PROCESSES

The bathymetric details obtained from studies of Chandramohan et al 1993 are provided which is shown in Figure 6. The tide levels at Satapada before opening of the mouth(March 2000) was 10 cm, while this improved to 60 cm in March, 2001 and the figures in March 2012 stood at 45 cm. The tidal chart is shown in Figure 7. The tidal variations were observed and it was about 2m.

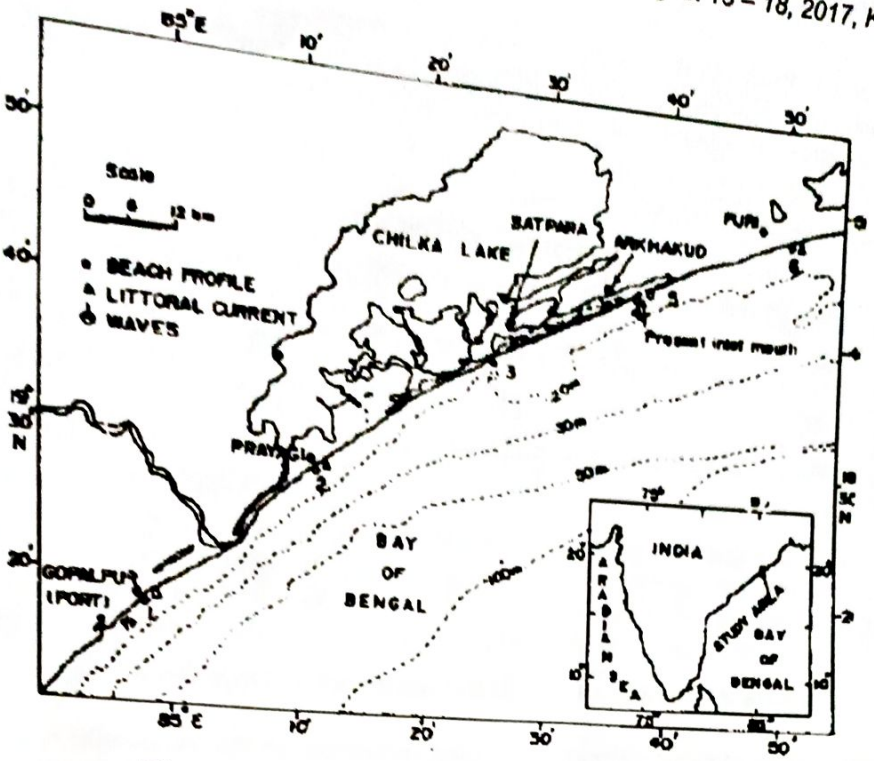


Figure 6. Bathymetric details of Bay of Bengal

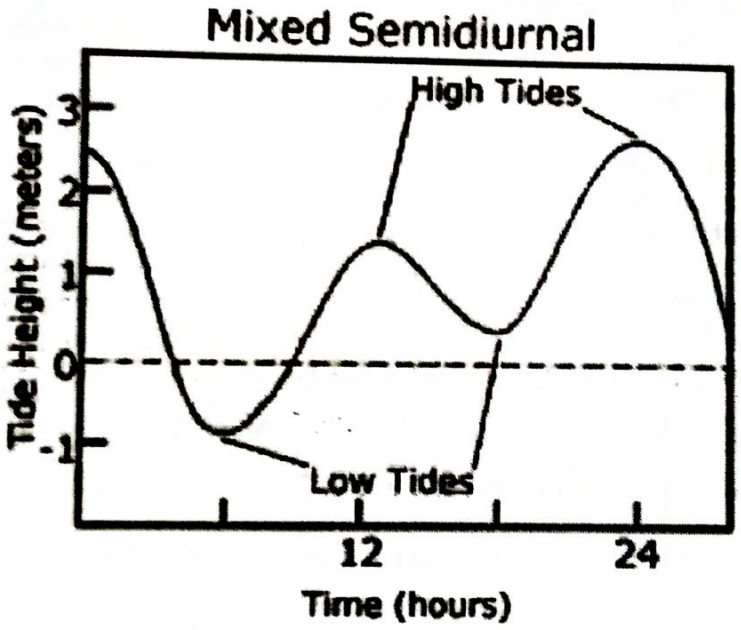


Figure 7. Tidal chart for the site location

7 ALONGSHORE SEDIMENT TRANSPORT

The gross longshore sediment transport rate is about 1. X 10^6 m^3 / year. The net sediment is towards north from May to October and is about 0.7 X 10^6 m^3 / year as per studies and measurements by Chandramohan et al (1993). The sediment transport is predominantly directed towards north direction. In a year the alongshore sediment transport is directed towards north from May to October and towards south from November to February. The south west monsoon is active and during this period rivers carry large discharge and also bring enormous sediments. Hence during monsoon, the estuary is flushed by flood waters. Considerable siltation is observed during fair weather period. Observation on sediments along Mahanadhi was studied in detail by Central water Commission (2015) from 2002 to 2012. The average annual sediment is workout to 4.44 million metric tons.

8 RAINFALL DETAILS

The details of rainfall are analyzed as per Mishra and Jena (2015). Chilika lagoon receives flow from distributaries of Daya and Bhargovi in Mahanadi delta join the sea via Chilika lagoon which is shown in Figure 8. The variations of Chilika are in terms of geomorphology, ecology and biodiversity for changes in

2006, 2008, 2011 and 2014. Year 2000 was the minimum discharge year of the millennium. The tourist, flora and aqua catch decreased remarkably 1995-2000 for lagoon's reduced salinity, siltation and biodiversity. The anomaly in monsoon precipitation has trimmed down the threshold flushing flow to maintain salinity.

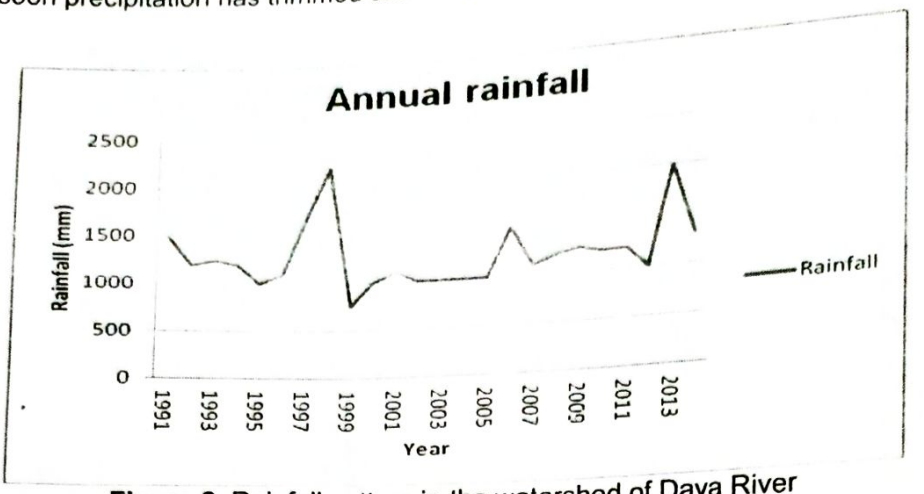


Figure 8. Rainfall pattern in the watershed of Daya River

The coast is vulnerable to cyclone during north east monsoon. In the year 1999 it was subjected to a super cyclonic storm. Another very severe cyclonic storm Phailin crossed the coast in 2013.

9 WATER RESOURCES AND CLIMATE CHANGES

Climate change is expected to have implications for several wetland features. The main diverse in Chilika are decrease in monsoon rainfall, increased temperature, sea level rise and tropical cyclone events. It has also impacts on winter rainfall in India where drought and flood situation is quite normal. The storms, surcharges and cyclones occurred frequently in coastal area of Odisha which has got bad impacts on the coastal lake ecosystem. During the heavy flood the sediment along with the nutrients load and debris enter to Chilika Lake and will cause siltation and eutrophication.

Due to impact of climate change the lake mouth was shifting at a faster rate and also Chilika catchment has been receiving erratic rainfall. When more precipitation will occur in the catchment area, the water logging will take place and the paddy field of the Kanas, Delanga and Brahmagiri blocks of the lake will get submerged. Figure 9 is showing the area of water logging by flooding is enclosed.

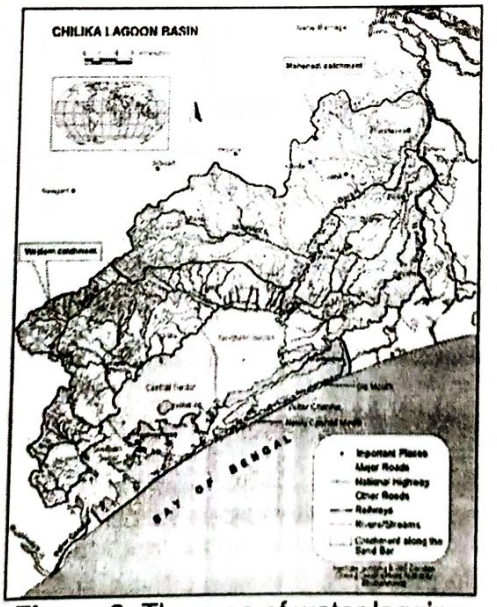


Figure 9. The area of water logging
By Flooding

The lake has faced two consecutive cyclones in the year 2013 the cyclone 'Phailin' had the landfall in the close proximity in Chilika lake on 12.10.2013 and another high impact cyclone also hit in the southern part of Chilika lake called 'Hud Hud' on the same day, next year i.e. 12.10.2014 followed by a severe flood in the river system draining to Chilika lake. This has become a regular practice in these areas a cyclone, drought or flood experienced in every year. The occurred adverse climate phenomena is listed in Table 1.

Table 1. List of occurrence of adverse climate phenomena

S.No	Category	Year of Occurrence
1.	Flood	1956, 1959, 1969, 1970, 1986, 1987, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2001, 2003, 2005, 2006, 2008, 2011, 2014
2.	Cyclone	1967, 1968, 1970, 1971, 1972, 1973, 1999, 2013, 2014
3.	Drought	1956, 1970, 1987, 2000, 2002, 2010, 2015
4.	Earthquake	2013, 2015

10 DESILTATION OF THE CHANNELS

From the above observation it has been felt that some further interventions inside the lake are essential like the desiltation in the main connecting channel from the mouth to lake, Balugaon Channel and a Ferry route is shown in Figure 10. The ferry route will be maintained for years together as the propeller of the boats moving inside will make the channel free from siltation. The depth of ferry route with respect to mean sea level is shown in Figure 11.

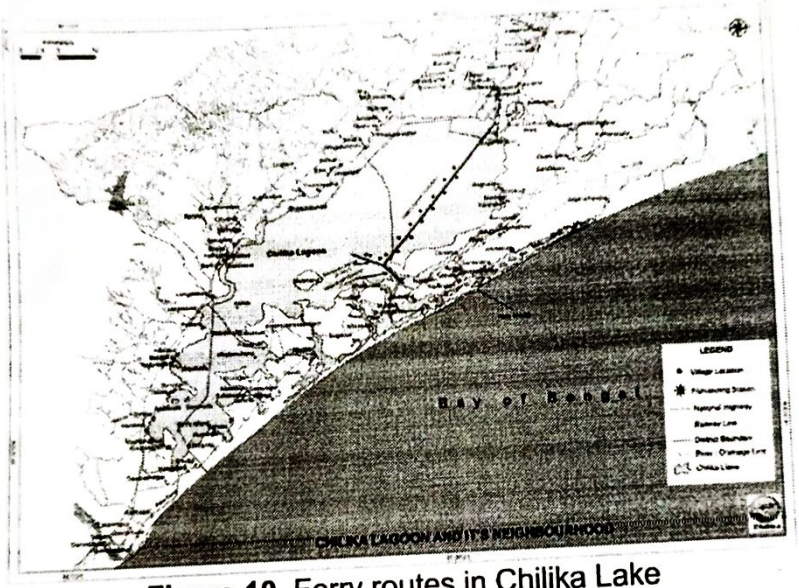
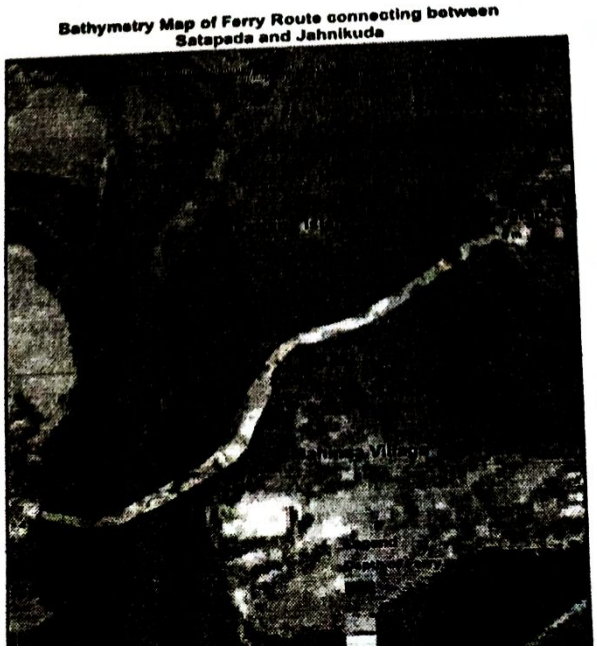


Figure 10. Ferry routes in Chilika Lake

The Balugaon Channel is the interface between the main lake and also the Outer channel of Chilika. The recruitment of Fish and Fish Juveniles are taking place through Balugaon channel only and so the extension of the Balugaon Channel is in evitable for maintaining the fish production of the Lake.



By desiltation of the channels the navigation in the lake will improve. The desiltation processes will also pave the way for the recruitment of Juvenile from Sea as 85% of the fish in Chilika Lake are migratory in nature. The lead dredged channel also facilitate in discharge of flood water from Delanga, Kansa and Brahmagiri block, in the Mahanadi Catchment (Chilika) in Puri district of Odisha which is more than 70,000 hectare of cultivable agriculture land

11 SUMMARY

The opening of the mouth at Sipakuda in 2000 resulted in annual fish production from 2000 tonnes to 14000 tonnes in 2003. The annual fish yield of Chilika has decreased from 14,000 tonnes (2003-04) to around 12,000 tonnes. The tide levels at Satapada before opening of the mouth(March 2000) was 10 cm, while this improved to 60 cm in March, 2001 and the figures in March 2012 stood at 45 cm. Chilika as a brackish water lake is known for its substantially coverage of seagrass beds which acts as carbon sinks (blue carbon). Based on the outcome of this successful hydrological intervention, the Ramsar Wetland Conservation Award and Evian special prize 2002, which is the award of highest order by the Ramsar bureau for outstanding achievement in the field of restoration of the wetlands is conferred on CDA. Chilika was also removed from threatened list of Wetlands i.e. Montreux record in 2002. CDA is the first recipient of this prestigious award from Asiatic region.

Chilika estuary is mainly influenced by sediment transport by rivers into the lake and alongshore sediment transport along the coast towards north by wave action. The mouth is also migrating towards north due to deposition of sand in the south and erosion in the north of the mouth. The coast is also vulnerable to cyclone and this can also alter the mouth configuration. Substantial rainfall creates runoff in to inlet and creates flushing of mouth. During below average rainfall the mouth gets closed and there is no proper tidal prism action.

If proper desiltation of channels inside the lake and lake to outer channel is carried out the high siltation can be flushed out during substantial rain fall and the rate of migration of mouth can be reduced. Dredging of channels in the lake will also help movement and distribution of fishes, seaward breeding migration etc.

REFERENCES

Chandramohan P.V, Sanil Kumar V and Naya B.U. (1993). Coastal process along shorefront of Chilika Lake east coast of India. *International Journal of Marine Science*, Volume 22, No.3 Jan-Dec 1993, 268-272.

Government of India, Ministry of Water Resources, Central Water Commission (2015). *Integrated Hydrologic Hand book*. Non classified river basins January 2015.

Mishra S.P and Jena J.(2015). Analytical study of monsoon rainfall south Mahanadhi delta and Chilika lagoon Odisha. *International Journal of Science and Technology*, Volume 7, No.3 Jan-Jun 2015, 985-996.

Venkataratnam K. (1970). Formation of the barrier spit and other sand ridges near Lake Chilika on the east coast of India. *Marine Geology*, Volume 9 (1970), 101-116.

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PREFACE

This course book titled, on **"PROBLEM SOLVING AND PYTHON PROGRAMMING"** has been written for First Semester B.E., B.Tech students of Anna University, Chennai – 25 as per new regulations & syllabus 2017. It consists of five chapters and a snapshot version of each chapter is given below:

Unit I gives an **"Algorithmic problem solving"** by expounding the basic tenets of algorithm, flowchart, Pseudocode and program design techniques.

Unit II is titled as, **"Data, Expressions, Statements"** explains the basic structure of python programming, operators, various Input Output statements and Functions.

Unit III entitled, **"Control Flow, Functions"** describes the procedures of various branching and looping techniques and basic idea on string and its functions.

Unit IV is titled as **"Lists, Tuples, Dictionaries"** describes the most important datatypes available in python with its detailed functions and methods.

Unit V entitled, **"Files, Modules, Packages"** explains how to create, read, write data into text file and Exception handling methods and brief idea about modules and packages.

The add-on value of this book is the enunciation of concepts using syntax, algorithm and programming illustrations in simple and direct language.

Suggestions and comments from the readers are solicited for further improvement.

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An Efficient Implementation of Tower of Hanoi using Gray Codes

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Abstract

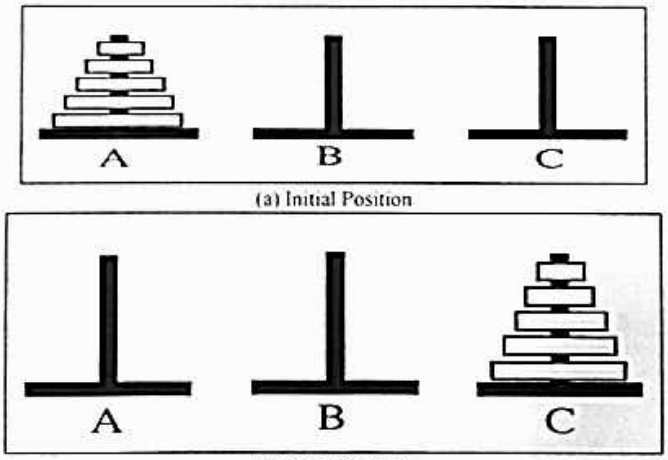
The Tower of Hanoi Puzzle finds its applications ranging from robotics to psychological research. This puzzle is a classic case of recursive algorithm in programming. However, this puzzle can also be implemented using iterative programming, by using binary codes or gray codes. Various applications require an optimized solution for this puzzle. In this paper, an efficient implementation of Tower of Hanoi using Gray codes for 'n' disks and three rods is presented. This focuses only on minimizing storage and reducing running time as required by many applications. The proposed implementation using Gray code system consumes lesser memory and slightly reduced running time compared to the conventional recursive methodology.

Keyword- Tower of Hanoi; Gray Codes; Recursion; Non-recursive algorithm

I. INTRODUCTION

The Tower of Hanoi, a mathematical game or puzzle, was invented by E. Lucas in 1883 [1, 3]. It consists of three rods, and a number of disks of different sizes which can slide onto any rod. The disks in a stack are arranged in ascending order of size on one rod, the smallest at the top, thus making a conical shape [4]. The objective of this puzzle is to move the entire stack from one rod to another rod using an intermediate rod, following the three rules: (i) Only one disk can be moved at a time. (ii) Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e., a disk can only be moved if it is the uppermost disk on a stack and (iii) No larger disk may be placed on top of a smaller disk. Figure 1 represents the initial and final positions of Tower of Hanoi. The minimum number of moves required to solve a Tower of Hanoi puzzle is $(2n - 1)$, where n is the number of disks. With three disks, the puzzle can be solved in seven moves. The problem is isomorphic to finding a Hamiltonian path on an n-hypercube [5, 6].

The Tower of Hanoi puzzle is used in different applications [7]. It is used as a backup rotation scheme for performing computer data backups where multiple tapes or media are involved. It provides a good standardized test bed to evaluate integration of high-level reasoning capabilities of robots together with their manipulation and perception aspects. It is frequently used in psychological research on problem solving. The Tower of Hanoi is also used as a test by neuropsychologists trying to evaluate frontal lobe deficits [7].



(a) Initial Position

(b) Final Position

Fig. 1: Tower of Hanoi Puzzle

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COMPUSOFT

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A REST API APPROACH TO INTEGRATE PERFORMANCE MANAGEMENT SYSTEM WITH SERVICE DESK APPLICATIONS

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Abstract:—Most of the world's largest deployments of virtualization, monitoring and reporting require IT services to be fast, simple and complete. Setting thresholds for more number of metrics evaluating performance complex, requires expert analysis and is time consuming. In many cases, the thresholds are time-varying and not set manually. The Performance Management System is a boosting solution for various virtual and cloud based IT infrastructures. The system has been striving to offer REST APIs for integration with third party IT management/service desk applications. Using the REST APIs, the data can be extracted, new applications can be developed or data can be integrated with existing applications. These REST APIs are independent of programming languages. The response data is also language independent. High service uptime, increased user productivity and satisfaction, reduced operational costs and effective capacity planning and optimization are some of the key benefits.

Keywords: API, Monitoring systems, cloud

1 Introduction

1.1 Monitoring

The word 'Monitoring' acknowledges the concept of overlook and to keep an eye on the things that are happening. Computer applications are the backbone of today's business services and their *performance* has a trademark on the organization's turnover and quality.

Constant monitoring on the quality of services offered stands to be the primary component for the framework management and increased performance strategies

1.2 Performance Monitoring Systems

A number of governments, private agencies have begun to develop performance monitoring systems. A host of methods have been developed that provides information on quality and on program outcomes. Procedures are available to consider the influence of client characteristics, local conditions and other factors beyond control. Performance should be defined broadly enough to capture the key dimensions that are of interest to important stakeholders. Only after this process it is possible to assess the relevance and utility of potential measures. After the selection of related metrics, it is monitored via agents, programmed data via surveys, ratings, evaluation via studies thus proving to be cost effective. [4]

Performance monitoring can do the following:

- It detects elemental problems before they have an injurious effect.
- Encounter obstacles that disturb the user's production.
- Gather information when a dispute emerges for the first time.

Creating a standard comparison for a successful monitoring involves the following:

- Systematically obtain the performance statistics from the operating system.
- Accumulate the data for long term support and maintenance monitoring.
- Demonstrate the information for the profit of the system administrator.
- Disclose situations that emphasize extra data compilation or reacting to indications from the system administrator to collect such data, or both.
- Contributing to assimilate all the data resources and store the same, Track the updation made.

2 Existing Monitoring Techniques and its controversies

In this paper, the various strategies in which the performance monitoring has been utilized for various concern are discussed below.

2.1 Inventory Management

Imagine an ERP system, which has an inventory of thousands of electrical parts and products across its stocking locations, is critical to handle. Furthermore, a strategy of acquiring successful, locally operated business for growth has meant that it needs solid monitoring of existing as well as the new processes. Implementing this business strategy required high-end performance that scales and remains stable without any failure. If there is a chance where performance remains poor, system crash and meager visibility to the system's process threatens the entire structure. Finally its the business-critical measures, that emphasizes the performance management for troubleshooting with a proper assessment.

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A SURVEY OF NOVEL CENTRALIZED ARCHIVAL SYSTEMS THAT HANDLE LARGE VOLUME OF MULTIMEDIA DATA

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Abstract— The process of retaining data that is not actively by any organization to a separate storage device for long-term preservation is called Data archiving. Archives consists of older data that is may or may not be important to the organization, these data that might be needed for future reference, as well as some data that must be retained for legal purposes. Archives protect old data that is not needed for everyday operation but may need to be taken into consideration for computation in future. These data archives serve as a way of reducing primary storage consumption and its related costs. They are not data recovery mechanisms and they are usually indexed and that have search facilities so files or parts of files can be easily located and retrieved or managed using the directory structure. This paper deals with prototype systems of proposed paradigm which use centralized archival system over the network to facilitate users for maintaining, sharing, updating, searching, and processing multimedia information consistently. This paper deals with different archival systems that differ from the existing systems in one aspect or the other.

Keywords— Multimedia archival system (MAS); centralized, reliability; security; availability; dynamic; archives; metadata; compliance

I. INTRODUCTION

Multimedia Archival system (MAS) - the multimedia archival system is a software program or web based application that manages the creation, storage, and control of the document, audio video files. The primary function of MAS is to manage electronic information within an organization. A basic MAS should include file management, sharing, and retrieval facilities. MAS should provide Security, Version Controlling, and must capture meta data.

- Security: This function controls which users has access to which information and restricts the availability of data to users based on their privileges since any system that a user uses must be able to protect highly confidential data.
- Version Controlling: MAS should allow users to add documents to the system and must be capable of maintaining the changes made by the user as different versions or must be able to keep track of the changes.
- Capturing metadata: Metadata is data that describes and gives information about other data. MAS should allow users to capture and use the appropriate metadata for maintaining and retrieving purpose from archives.

In addition, A MAS must be capable of providing secure access, should maintain context, and execute disposition instructions for all records in the system along with concurrency and consistency. Most of the files that are archived are rarely modified and written only once. Therefore, maintaining the write operation traffic is rather small. However, the system has a relatively higher traffic in sequential reads.

A. Approaches for Handling multimedia data

Centralized approach: when a collection of database is located, stored, and maintained in a single location it is termed as centralized approach.

Network file system approach: when data is being served over a network, with the physical storage units and their management hosted by a different entity it is termed as networked approach.

Distributed File System approach: when data is spread across multiple systems it is termed as distributed approach. Here the requesting system is a different system than the underlying physical storage or its management system which is controlled by a server.

B. Potential threats and benefits of using centralized system

Benefits of centralized file storage

This full-text paper was peer-reviewed and accepted to be presented at the IEEE WiSPNET 2017 conference.

Establishing Trust Despite Attacks in Cloud Computing: A Survey

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***Abstract*—Cloud computing has become an integral part of our lives as it provides on-demand, rapid provisioning of services with ease of implementation, accessibility and flexibility. The pay-as-you-use aspect is very attractive for customers who usually pay fixed price for resources whose usage does not tally with the cost of purchase. In this paper, we present a survey on security in cloud computing despite various attacks. It presents the various security aspects in the services provided by the cloud such as IaaS, PaaS and SaaS. Since virtualization is used vastly in cloud, we take a look at the various attacks virtual machines are subjected to. Trusted computing was introduced for the customers to be assured that the resources they use over cloud is reliable. Further, we also observe how remote attestation plays a role to assure trustworthiness and how the Trusted Platform Module is used in the attestation mechanism. The paper thus provides an overall view of existing techniques to secure and trust cloud and its components.**

***Index Terms*—Cloud Computing, Security, Virtual Machine, Attacks, Trusted Computing.**

I. Introduction

Cloud computing has now become a term that any household with a computer connected to the Internet is familiar with. To put it in simple terms, cloud computing provides access to a shared pool of processing and storage resources on demand. This is a technology that has a history of evolution starting from mainframe computers, travelling through virtualization, virtual private network (VPN) connections, grid computing, and utility computing [1]. Various services such as Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and pretty much everything as a Service (XaaS) are provided over public, private, community or hybrid clouds [2]. When deploying a variety of services using various resources to different targets, security becomes a major concern. Even if cloud computing ceases to hold the title of being the latest technology, it will still continue to be used on a large scale. It will act as a backbone for the latest emerging technologies. This necessitates cloud to defend and armour itself – resources and data included – against a multitude of attacks.

Instead of tackling the sophisticated higher levels of protection, the Trusted Computing Group (TCG) introduced trusted computing which assured security at system level by ensuring the computer behaves in an expected manner [3]. This trustworthiness of a resource on cloud should be verifiable by a user which led to the concept of remote attestation. This paper lists some of the common attacks that virtual machines are subjected to. It explores and observes the various techniques used to make trusted computing and remote attestation possible.

The rest of the paper is organised as follows: Section II revisits the basics of virtual machines and trusted platform module. Section III presents the security aspects of SaaS, PaaS and IaaS. Section IV presents the attacks on virtual machines. Section V deals with trusted platform module and remote attestation. Section VI deals with the concluding remarks of this paper.

II. Revisiting Basics

Virtualization is the fundamental technology that enables cloud computing. It enables to create a virtual representation of an actual physical hardware device or resource. This virtual representation is called a virtual machine (VM). There are different resources that can be virtualized including (but not limited to) storage, servers, operating systems, networks and applications. A VM acts as an independent computer with emulated versions of processor, memory, network adapter, peripherals and removable drives. These virtualized resources are managed by a guest OS. A middleware layer called Virtual Machine Monitor (VMM) or the hypervisor helps to create and run these VMs.

A virtual machine is prone to any and every security threat as that of a physical machine, even more so. Confidentiality, privacy, integrity and availability are primary concerns with regards to security. Trusted computing was introduced as an all-enclosing technique to assure trustworthiness of resources. According to Bare [4], trusted computing should supply the following features:- (i) Remote attestation (ii) Secure boot (iii) Sealed storage (iv) Secure input/output (v) Curtained memory and (vi) Integrity measurement.

Trusted Platform Module (TPM) was brought as a vehicle of deployment. The TPM is a cryptographic chip that is capable of generating, storing and protecting cryptographic keys that may be symmetric or asymmetric in nature. It monitors the system configuration state, controls access related to configuration data and can attest to third parties regarding the same. Coker et al. [5] defined root of trust in terms of measurement, storage and reporting as follows:

"A root of trust for measurement is a hardware device (or some functionality provided by hardware) that can reliably prepare certain measurements on the software state of a device. A root of trust for reporting is a hardware device (or some

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Machine Learning Techniques for Prediction of Ambient Air Quality Levels: A Survey

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Abstract—Rapid industrialization has resulted in the imbalance of chemical composition of air. This in turn has degraded the ambient air quality thereby affecting life, property and environment. Air quality forecast models can help environmentalists study the factors deteriorating air quality and also warn the public to take precautionary measures to avoid or limit their exposure to unhealthy levels of air pollution. Extensive research has been carried out in the pursuit of developing effective forecast models that integrate various statistical and data analysis tools. Forecast models generally employ machine learning techniques in addition to data mining concepts. This paper focuses on a comprehensive review of numerous existing air quality forecasting models which uses various machine learning approaches.

Key words: Machine learning; Air quality level; Forecasting models; Data Mining

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COMPUSOFT

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A Survey On Developing A Client-Server Architecture To Replicate Kiosk Based Services Using An Android Mobile Application

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Abstract: Modern hand held devices such as mobile phones and PDAs have become increasingly powerful in the recent years. As mobile devices have become more like PCs they have come to replace the objects that we once used to carry around, like credit cards, check books, planners etc. This paper is one such proposal to replace the use of smart card and kiosk services in an organization. The objective of this project is to provide all the functionalities that were earlier in existence using the KIOSK modules but coupled with mobility with the main emphasis being laid on canteen management service and other e-cash services that one requires within the organization. This is proposed to be achieved by the development of a native android mobile application. The mobile application allows the employees to login for availing the said services using their unique employee ID and four digit PIN number. A different menu is generated for different days of the week and the employee can select their preferred choices and the queries get accumulated at the server. The application serves almost as an e-wallet inside the organization. The server is built to implement scalability and robustness to take million query requests from the large number of employees of an organization. The design of the user interface follows a user-centered design approach considering key aspects of mobile app development.

Keywords: mobile, KIOSK, native android application; user-centered design.

I. INTRODUCTION

Mobile application is a new way to build business and promote growth. It enhances speed, efficiency in transactions and controls volume of information. As part of the development process, mobile user interface (UI) design is also essential in the creation of mobile apps. Mobile UI considers constraints, contexts, screen, input, and mobility as outlines for design. The user is often the focus of interaction with their device, and the interface entails components of both hardware and software. The major benefit of using mobile application is that it works on a completely digitized platform. Hence survey is based on developing an android application for a governmental organization to mitigate cash transactions and provide an interface for the employees within the organization to perform transactions on-the-go. The survey is conducted by improvising on the security environment and encrypting the details about the employee in order to provide a secure path for payment.

II. EXISTING SYSTEM

As already mentioned, this project is aimed at replacing the objects like credit cards, smart cards, cheque books etc. that are carried around by us and cohesively bringing its functionalities and capabilities on a hand-held device. The existing system includes a smart card issued to each employee during their tenure in the organization. The smart card is associated with a unique employee ID of that belonging to the employee and his/her four-digit high security PIN number. A smart card reader is available with the kiosk. The smart card readers and the terminals operate with the smart card to obtain information and enable the employees to avail their entitled services. The smart card reader is of the contactless type and works with a radio frequency when the card comes close to the reader. Unlike readers, terminals are similar to a self-contained PC and perform the necessary transactions, with most featuring development tools. Connectivity in the terminals is via Transmission Control Protocol/Internet Protocol (TCP-IP) or GSM network. The kiosk here plays the role of an interactive computer terminal that provides access to the information pertaining to the

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HAZE REMOVAL IN IMAGES USING DARK CHANNEL BASED IMAGE ENHANCEMENT

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ABSTRACT--- Haze is the degradation of outdoor images which weakens both the colour and contrast of the image.This can occur due to the presence of fog, mist, and other atmospheric phenomena. The dark channel prior is a kind of statistics of the haze-free outdoor images. A simple and effective dark channel prior is required to remove haze from a single input image. Most of the local patches in haze free outdoor images contain some pixels which have very low intensities in atleast one colour channel. Using this prior with the haze imaging model, the thickness of the haze can be estimated and a high quality haze-free image can be recovered. The haze free image can be enhanced by a guided filter which performs edge preserving smoothing and also removes the noises from the dehazed image. The major purpose of the Haze removal can be elaborated, considering the places that are covered with extreme presence of fog, haze etc. In such places, the removal of Haze provides a way by which the presence of intruders and other terrorists can be identified easily.

KEYWORDS--- Haze removal, Dehazing, Dark Channel, Guided filter, fixing epsilon values

I. INTRODUCTION

Images of outdoor scenes are usually degraded by the turbid medium such as particles and water-droplets in the atmosphere. Haze, fog and smoke are such phenomena due to atmospheric absorption and scattering. The irradiance received by the camera from the scene point is attenuated along the line of sight. Furthermore, the incoming light is blended with the airlight. The degraded images lose the contrast and color fidelity. Since the amount of scattering depends on the distances of the scene points from the camera, the degradation is spatial-variant.

Haze removal is highly desired in both consumer/ computational photography and computer vision applications. First, removing haze can significantly increase the visibility of the scene and correct the color shift caused by the air-light. However, haze removal is a challenging problem because the haze is dependent on the unknown depth information. The problem is under-constrained if the input is only a single haze image. Therefore, many methods have been proposed by using multiple images or additional information. Single image haze removal has made significant progresses. The success of these methods lies in using a stronger prior or assumption.

II. EXISTING SYSTEM

A) DARK CHANNEL:-

In computer vision and computer graphics, the model widely used to describe the formation for a haze image is:

$$I(x) = J(x)t(x) + A(1 - t(x))\ldots (1)$$

Where x is the pixel coordinate. $I(x)$ is the observed intensity, $J(x)$ is the scene radiance, A is the global atmospheric light, and $t(x)$ is the medium transmission describing the portion of the light that is not scattered and reaches the camera. A, $J(x)$ and $I(x)$ are vectors. The first term $J(x)t(x)$ on the right of Eq.(1) is called direct attenuation and the second term $A(1 - t(x))$ is called air-light.

When the atmosphere is homogenous, $t(x)$ can be expressed as:

$$t(x) = e^{\wedge}(-\beta d(x))$$

where β is the scattering coefficient of the atmosphere, and $d(x)$ is the scene depth which is the distance from the object to the camera.

The dark channel prior is based on the following observation on haze-free outdoor images: in most of the non-sky patches, atleast one color channel has very low intensity at some pixels. In other words, the minimum intensity in such a patch should have a very low value. Formally, for an image J, we define

$$J^{dark}(x) = \min(\min(J^{c}(y)))$$

The steps in the existing system include:

- Obtain the input image for which the Haze removal is to be performed.
- Using the above input image, remove the haze present using dark channel based removal.

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INTEGRATED PLATFORM DEVELOPMENT OF WEB AND CAMPUS INFORMATION

EZHILMANI AAKAASH, SURESH T, MOHAMED FAROOK ALLO
GUIDE: V SUNDARI

Abstract — The usual scenario to obtain information is to browse the internet or have it stored in a local drive. This can be tedious at times due to its difficulty in searching and the time cap. To overcome this sort of situation and manage time, a smart phone based application is developed. This helps out in browsing and obtaining information while on the move with ease. All that it requires is internet connection. This is achieved using Android which is basically an open source software that allows one to create his her own application. This idea has been inculcated in developing an application for a university that makes interaction and exchange of information an easy task, by the press of a button. This paper aims at facilitating information such as important notes, materials and even pushes notifications. All of this is achieved with the help of JSON that converts data into the required format by making a service hit and retrieves only the data that is needed. This application makes it easier to keep track of mark sheets, student details and even notes which maybe in a pictorial or handwritten form.

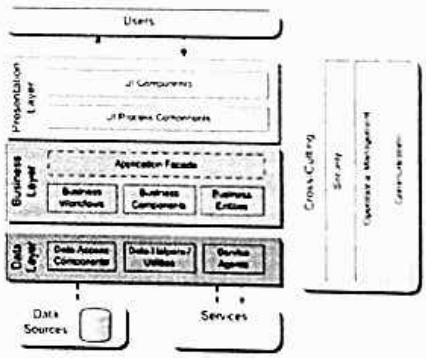
Index terms— Android, Web Service, JSON, PhP.

I. INTRODUCTION

Android is an open source project led by Google called AOSP (Android Open Source Project). Google uses this project as a base to create its version of Android, which is then used by the other manufacturers.

In addition to being an operating system, Android is a software bunch that offers both middleware interaction and key applications. It comes with a marketplace that offers a variety of applications for users to download. Android applications are written in Java programming language. Android, as mentioned before, is available as open source for developers to develop applications which can be further used for selling in android market. There are about 200000 applications developed for android with over 3 billion-downloads. Android relies on Linux for core system services such as security, memory management, process management, network stack, and driver model.

At the server end, a web service is used. Web service is basically an open standard functionality whose sole purpose is to provide interoperability and inter-communication among machines and users. A web service is available throughout the internet and is accessed via the World Wide Web (www). It makes use of a standardized XML format to encode all communications. It is a conjunction of UDDI, WSDL and SOAP. These services are also platform independent i.e., a person with working on a Windows server can interact with a server of different platform or even access data of different format.



As an intermediate, JSON service has been put to use. Earlier, XML was the primary format for information exchange. JSON, Javascript Object Notation, considered a subset of Javascript language, took over this process due to its more lightweight nature. Its language independent nature makes reading and writing easier for humans and parsing for machines.

One of the most distinct and main features of JSON is its simplicity. Unlike XML, JSON is more human readable and is more data-oriented making communication a lightweight process.

Rest API or Representational State Transfer of web service is basically a functionality that aims at providing interoperability just like JSON, SOAP and WSDL. With stateless being its core fundamental, Rest API strives to provide faster performance, better results and also, consume less bandwidth. Rest consists of 6 architectural constraints that form the heart of this interface. Here, REST provides

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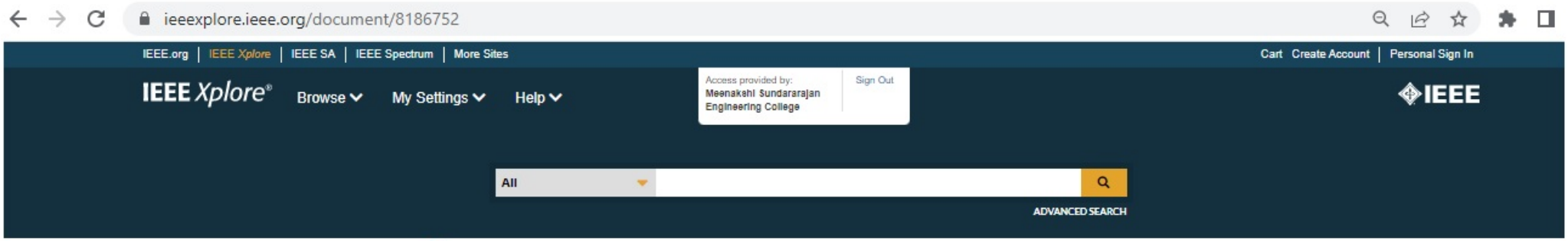

An adaptive e-learning environment centred on learner's emotional behaviour

Publisher: IEEE

Cite This PDF

A. Kanimozhi ; V. Cyril Raj All Authors

Abstract:
Recent trends in Information and Communication Technology, Web based learning environment attract the learner for anywhere and anytime learning such as e-learning environment. Many research says that the learner's active listening duration is 15 to 20 minutes and research on e-learning mainly focusing to offer an adaptive e-learning content with respect to the learner's profile and knowledge. This paper, we are mainly focused, how to engage the student in e-learning for longer duration. To keep the learner, in active listening mood, we have to recognize the learner mood and offer the adaptive learning content with respect to their mood, knowledge in the domain, profile and Learner history feedback. We focused to reveal the learner's emotional behavior, we have taken Facial feature emotion extraction, body gesture, movement and EEG — Bio signal approach for emotion prediction. The result was analyzed and it shows that bio-signal accurately predicting the learner's emotion. Finally, we have used the EEG approach for predicting the learner's emotional behavior while learning.

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PREFACE

Python as a Programming Language is a very great resource for programmers and is also an Open Source Programming Language. Python can be your stepping stone into the programming universe. Python is an object-oriented language, just like Javascript, C++, C#, Perl, Ruby, and other key programming languages. It serves as an excellent language for beginners. It is highly-preferred for Data Analytics and Machine learning.

This book is highly recommended for the under graduate first year engineering students, who are interested in learning basic concepts of python programming. It covers Anna university 2017 regulation syllabus. It is a good source to enhance the programming skills of students.

The first chapter covers the problem solving concepts which serves as a stepping stone to programming. The next chapter covers the syntax or grammar in python. Successive chapters cover the interesting features of python such as lists, tuples, dictionaries. The last chapter concentrates on the concept of files and exception handling.

This book contains numerous programs and examples. These programs were implemented and tested using python interpreter. Pictorial descriptions of concepts are included for better understanding.

I would like to thank Mrs. Akila for her astonishing ability to spot mistakes that had somehow managed to go unnoticed by myself.

Learners are encouraged to give any suggestions or feedback for further improvement to this mail id pria.manikandan@gmail.com

ABOUT THE AUTHOR

J.Priya, is currently working as Assistant professor, Department of Information Technology at Meenakshi Sundararajan Engineering College. She obtained her B.E degree at Jerusalem College of Engineering and M.E degree at S.A. Engineering College. She has close to eight years of teaching experience. Teaching is her passion thereby she loves to conceive new concepts, and apply them in an efficient way to benefit the students. Her style is infusing real world experiences through her instructions which makes the teaching moments fresh and thereby enriching classroom learning. Her focus towards students is outcome-based education to develop the requisite knowledge, skills, attitudes and habits of students. She has published papers in various international journals. Her major research areas include Database technology, Big data, Service Oriented Architecture, Data science using python.

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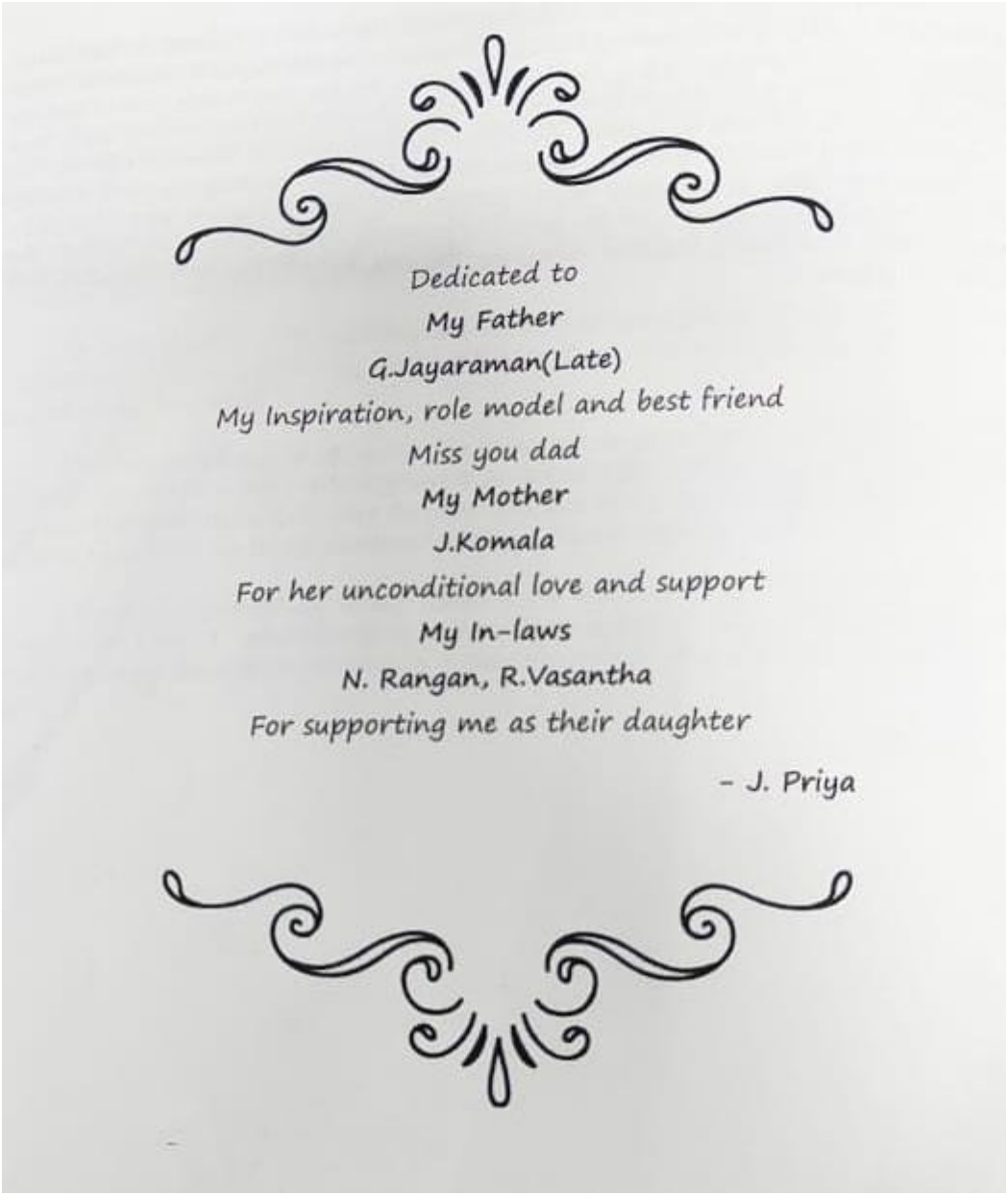
– J. Priya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My Inspiration, role model and best friend
Miss you dad
My Mother
J.Komala
For her unconditional love and support
My In-laws
N. Rangan, R.Vasantha
For supporting me as their daughter
- J. Priya

UNIT - 1

ALGORITHMIC PROBLEM SOLVING

UNIT - 2

DATA EXPRESSIONS, STATEMENTS

UNIT - 3

CONTROL FLOW, FUNCTIONS

UNIT - 4

LISTS, TUPLES, DICTIONARIES

UNIT - 5

FILES, MODULES AND PACKAGES