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Role of Research Methodology in Civil Engineering

Shubhra Upadhyay[1], Anupam Verma[2], Dr. N. K. Saxena[3]
[1]*P. G. Scholar, CED, KNIT Sultanpur;* [2]*Asst. Prof., CED, KNIT, Sultanpur;* [3]*Prof. & Head, CED, KNIT, Sultanpur*

Abstract: ***Research methodology is a method to consistently resolve the research problem. Research methodology may be termed as knowledge of science for studying how research is done empirically and theoretically. In this paper we have studied different steps that are usually taken by a researcher in studying his research problem of civil engineering along with the logic behind them. It is utmost important for the researcher to have the knowledge of the research techniques/method along with its methodology. Researchers also need to understand the presumptions underlying various techniques and they need to know the criteria by which they can decide that certain techniques and procedures will be applicable to certain problems and others will not. All this means that it is necessary for the researcher to design his methodology for his problem as the same may differ from problem to problem. Research methodologies are the need of hour due to modernization in research field of civil engineering. Nowadays only innovative research methods are adopted in branch of civil engineering like geotechnical engineering, geo-environmental engineering, structural engineering, geo-mechanics etc so that best results are obtained from these methodologies. In this paper we are going to discuss role of some of the research methodologies used for research purposes in geotechnical engineering for respective research problems.***

Keywords: Research methodology, geotechnical engineering, pushover analysis, FLAC method, numerical method,

I. INTRODUCTION

Research in common vernacular depicts a thirst for knowledge. Once can also define research as a scientific and systematic search for pertinent information on a specific topic. Overall, research is an art of scientific investigation. The Advanced Learner's Dictionary of Current English lays down the meaning of research as "a careful investigation or inquiry especially through search for new facts in any branch of knowledge." Redman and Mory define research as a "systematized effort to gain new knowledge."
Methodology defines the theoretical and systematic analysis of the methods applied to a field of study. It contains the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Basically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.[1]

A. Research Methodology

Research Methodology is science of studying how research is done scientifically. This is a way to systematically solve the research problem by logically adopting various steps. Methodology helps to understand not only the products of scientific inquiry but the process itself. Research Methodology aims to describe and analyze methods, throw light on their limitations and resources, clarify their limitations and resources, clarify their presuppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge.

II. OBJECTIVES OF RESEARCH

The purpose of research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out the truth which is hidden and which has not been discovered as yet. Though each research study has its own specific purpose, we may think of research objectives as falling into a number of following broad groupings:

1) To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory or formulate research studies);
2) To portray accurately the characteristics of a particular individual, situation or a group (studies with this object in view are known as descriptive research studies);
3) To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies);
4) To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis-testing research studies).

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A. Significance Of Research Methodologies In Civil Engineering

1) Research methodologies in civil engineering gives good and optimum results and their experimental and simulated data can be compared easily which will be very fruitful for the researchers.
2) It helps in framing of policies: Research helps in the framing of various government policies. Nearly all the government policies and budgets are planned and executed through research with the help of researcher. Annual budget, monthly budget, monetary and economic policies are all framed by the government. The government is assisted by various organizations for framing the policies through research.
3) Basic aim is to gain knowledge: It leads to many ideas and changes old facts.
4) It is used in business organization: Many business companies hire researcher to work on various things. It is used in studying the changes taking place in the market. It helps in capital budgeting, tax management and cost saving policies.
5) It leads to discovery and innovation of unknown facts and unexplored theories. It leads to the growth of the society and its citizens. It gives chance to the researcher to go deep into the subject and to innovate it.
6) It avoids superstitious beliefs, myths and prejudices: Many people are still not aware of the research activities and its importance. Many ancient beliefs and myths have been proven wrong with the help of research.
7) It leads to development of social welfare and society.
8) It is useful for PhD students to write their thesis.

Thus, Research is a fountain of knowledge, which helps in solving all the research problems, related to civil engineering, business problems, avoids superstitious beliefs and helps in the development and maturity of society and its citizens. [2]

III. RESEARCH METHODS

1) *Formulating The Research Problem:* There are two types of research problems, viz., those which relate to states of nature and those which relate to relationships between variables. At the very outset the researcher must single out the problem he wants to study, i.e., he must decide the general area of interest or aspect of a subject-matter that he would like to inquire into. Initially the problem may be stated in a broad general way and then the ambiguities, if any, relating to the problem be resolved. Then, the feasibility of a particular solution has to be considered before a working formulation of the problem can be set up. The formulation of a general topic into a specific research problem, thus, constitutes the first step in a scientific enquiry. Essentially two steps are involved in formulating the research problem, viz., understanding the problem thoroughly, and rephrasing the same into meaningful terms from an analytical point of view.
2) *Extensive Literature Survey:* Once the problem is formulated, a brief summary of it should be written down. It is compulsory for a research worker writing a thesis for a Ph.D. degree to write a synopsis of the topic and submit it to the necessary Committee or the Research Board for approval. At this juncture the researcher should undertake extensive literature survey connected with the problem. For this purpose, the abstracting and indexing journals and published or unpublished bibliographies are the first place to go to. Academic journals, conference proceedings, government reports, books etc., must be tapped depending on the nature of the problem. In this process, it should be remembered that one source will lead to another. The earlier studies, if any, which are similar to the study in hand, should be carefully studied. A good library will be a great help to the researcher at this stage.
3) *Developing A Working Hypothesis:* A research in any field of study do not give proper results unless and until we develop a working hypothesis. It is a tentative statement or assumption regarding the solution to the problem of study. It is an assumption which is used to draw the logical consequences. It is the key point of study and hence it should be limited and should contain much knowledge. It is helpful for researcher for predictions and also maintains complete focus on the study. It should be precise and clearly defined. It gives an idea of the type of data to be used and type of method or techniques for the study. In some research activities like exploratory or formulative, hypothesis is not used for testing. [3]
4) *Preparing The Research Design:* The research problem having been formulated in clear cut terms, the researcher will be required to prepare a research design, i.e., he will have to state the conceptual structure within which research would be conducted. The preparation of such a design facilitates research to be as efficient as possible yielding maximal information. In other words, the function of research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money. But how all these can be achieved depends mainly on the research purpose. Research purposes may be grouped into four categories, viz., (i) Exploration, (ii) Description, (iii) Diagnosis, and (iv) experimentation. A flexible research design which provides opportunity for considering many different aspects of a problem is considered appropriate if the purpose

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of the research study is that of exploration. But when the purpose happens to be an accurate description of a situation or of an association between variables, the suitable design will be one that minimizes bias and maximizes the reliability of the data collected and analyzed. There are several research designs, such as, experimental and non-experimental hypothesis testing. Experimental designs can be either informal designs (such as before-and-after without control, after-only with control, before-and-after with control) or formal designs (such as completely randomized design, randomized block design, Latin square design, simple and complex factorial designs), out of which the researcher must select one for his own project. The preparation of the research design, appropriate for a particular research problem, involves usually the consideration of the following: (i) the means of obtaining the information; (ii) the availability and skills of the researcher and his staff (if any); (iii) explanation of the way in which selected means of obtaining information will be organized and the reasoning leading to the selection; (iv) the time available for research; and (v) the cost factor relating to research, i.e., the finance available for the purpose.

IV. SOME OF THE RESEARCH METHODOLOGIES USED IN GEOTECHNICAL ENGINEERING (CASE STUDY)

1) *Numerical Method:* Numerical methods include such techniques as finite element, finite difference and boundary element. Depending upon geological media two approaches to numerical modelling is identified. A continuum approach treats the rock mass as continuum intersected by a number of discontinuities, while a discontinuum approach views the rock mass as an assemblage of independent blocks or particles (Goodman and John, 1977). Further, continuum models are of two types: differential and integral. Differential models characterize the entire region of interest and include the finite difference and the finite element methods. [4]
2) *FLAC Method:* Ground response in the study was obtained using the powerful FLAC method. The Fast Langrangian Analysis of Continua (FLAC) is a two dimensional explicit finite difference program. In order to setup a model to run a simulation with FLAC, in the fundamental components of the problem shall be specified: a finite difference grid, constitutive behavior and material properties and boundary and initial conditions. The general solution procedure as indicated in FLAC manual version 5.0 is adopted for the study. The Mohr- Coulomb model which is convenient is used in the study. [5]
3) *Pushover Analysis:* Pushover analysis is a simplified nonlinear analysis on structural members subjected to incremental lateral loads until failure. The central focus of this analysis is the generation of the pushover curve or capacity curve which brings out the relationship between base shear generated (lateral force applied to the structure) and corresponding roof displacement in lateral direction until collapse. This capacity curve is representation of the structures ability to resist the seismic demand. To generate the capacity curve, the structure is pushed in a representative lateral load pattern which is applied monotonically while the gravity loads are in place. Any type of representative lateral load pattern can be defined but the load pattern similar to first mode shape amplitude of the structure is the most commonly used to determine the capacity. For a given structure and ground motion, the displacement demand is an estimate of maximum expected response of building during ground motion. Once capacity curve and demand displacement are defined, a performance point can be determined. [6]
4) *CUED method:* Comprehensive Underground Excavation Design" called CUED method with emphasis on diagnosis of ground behavior and failure mechanism(s) in deep and hard rock conditions for long-term life expectations. The CUED method proposed in six steps including ground characterization, diagnosis of ground behavior, identifying failure mechanism, design analysis to manage ground behavior, construction, field measurements/monitoring and design update. A procedure has been defined for each step by determination of input data, processing data and output data, so-called IPO approach. IPO is applied to determine parameters of the CUED method in each step. Based on the proposed method, rock mass composition provides sufficient information to the diagnosis of ground behavior. [7]

Table No. 1. Some of the research methodologies used in civil engineering

Sl. No.	Methodology	Nature of Work
1.	Numerical Method	Time dependent behaviour of tunnels
2.	FLAC Method	phenomenon of squeezing of rock tunnel
3.	Pushover Analysis	assessing the capacity of geotechnical structures under a design earthquake demand
4.	CUED method	diagnosis of ground behaviour and failure mechanism(s) in deep and hard rock conditions for long-term life expectations

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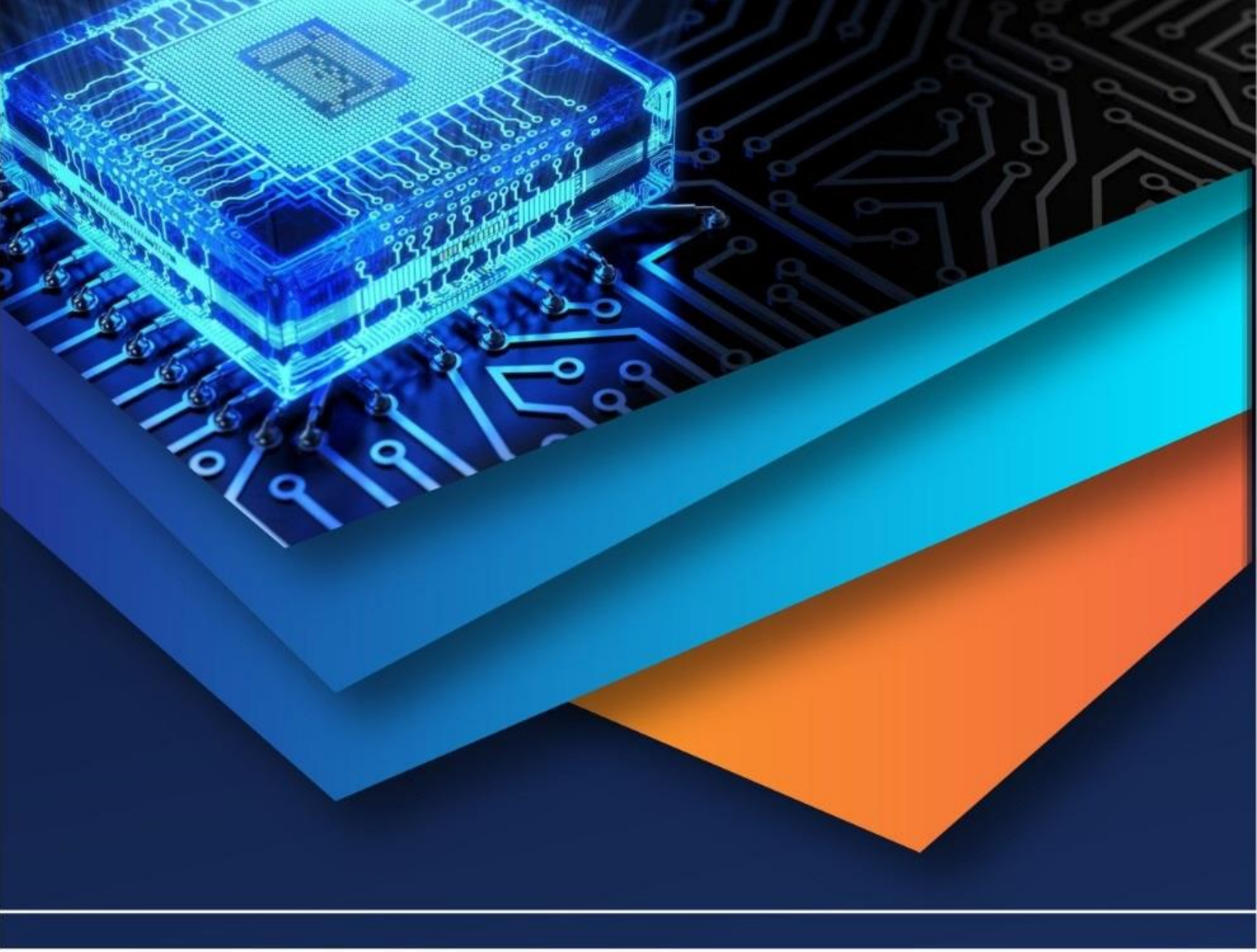
V. CONCLUSION

We have presented different methodologies that allowed a civil engineer to optimize the choice of design approach, when the observational method is believed to be a viable option. The methodology introduces a reliability constraint on the observational method that proves essential in establishing the acceptable limits of behavior for the preliminary design in accordance with the requirements in today's era. We believe that applying the methodology may contribute essential information to the design process, even if the engineer chooses to simplify the analysis. Thus, the methodology may prove to be a valuable tool for decision making engineer's everyday work with managing risks in geotechnical projects.

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