



# Applications of Softwares in Environmental Engineering

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## ABSTRACT

*Now-a-days technology and science go hand in hand, fertilizing each other by providing explosive synergy. The engineer can choose the appropriate software as per requirement from an innumerable variety of softwares of the different discipline of civil engineering. An engineer can go through the design process many more times fluently due to more efficient and rigorous results instantly. Moreover, Research means not to find or create something new at the door every time, but sometimes research means those things which have not yet been noticed, but they are of equally important. Through this concept, we decided to take this topic. The paper provides an overview of important software's which are used in the environmental engineering discipline of civil engineering. Due to the software application in engineering field efforts and time for complicated operations and calculations is reduced with efficient results. And there are several environmental software which is existing in market produced by relevant companies which enables the user to achieve the desired target with principle to improve the natural environment. We contribute the description of these softwares along with their applications in environmental engineering.*

**Keyword:** Software's, Applications, Environmental Engineering, Geo-Environmental Engineering.

## 1. INTRODUCTION

Now a day's technology is circulating in almost every field of human life whether it is in social, commercial, constructional or any other field. Regarding our project topic, well having the knowledge of software's is always an added advantage for a technically sound engineer.

Also, it is always said that along with the basic theory, it's important to learn its applications. And theory without software's aids is tedious and time consuming. This is the reason we have selected this topic. Moreover, everyone wants to study structural software's but we want to go for environmental software's along with them since many of us don't know about them. And it is said that it never hurts if you know more.

Now, it is possible to solve 90% of problems that one can face while studying or practicing environmental engineering using softwares. But just learning software's is not enough, we should go ahead and do some project work which will increase our knowledge and presentation skills and hence we have chosen this topic as our final year project.

## 2. STUDY OF APPLICATIONS OF SOFTWARE'S OF ENVIRONMENTAL ENGINEERING

We have studied some important environmental software's which a civil engineer should know along with structural softwares. These software's along with their applications are given below:

### 1. Matlab

MATLAB is software which has so many subsets that it can use in every field of engineering. It is used to write codes for solutions of complex functions, matrices and equations apart from preparing simulations, plotting variations etc. Many problems of structural engineering involve matrices of order more than 4 which are difficult to solve otherwise, can be solved easily by Matlab. Similarly, in case of other areas of civil engineering wherein students, researchers and professionals encounter equations of higher degrees, higher order differential equations etc. which require different methods to solve them, it becomes easy with Matlab.

Knowledge of MATLAB helps students to write effective, precise programs to solve civil engineering problems of different complexity which they usually face while writing C programs.

#### Applications

- Iterations and graphs  
We (civil engineers) have some empirical formulae and sometimes we do not have initial data to solve. So then we assume a value, use the formula and check whether it falls within the limits. Solving this problem is very difficult to do manually when we are dealing with large structures. So MATLAB does the iterations if we input data and formula. Similarly, for graphs sometimes the values are sensitive and the formula is difficult to plot in excel, so we use MATLAB. The basic functioning of MATLAB is like „C“ language but it can perform advanced calculations than „C“.
- Math and computation become easy with Matlab.
- Efficient Algorithm development
- Modeling, simulation, and prototyping are some basic uses of Matlab.
- Data analysis, exploration, and visualization is easy in case of Matlab.

#### 2. R Package (Open-air)

There are different R packages available in the market. One of them is openair. Openair is an R package which is used for analyzing air pollution measurement data but it is also of more useful in the atmospheric sciences. The package consists of many tools for bringing and then manipulating the data and performs a wide range of analyses to increase the understanding of air pollution data. It also provides introducing data from air pollution networks, source identification and characterization and the use of functions for model evaluation purposes. Moreover, it shows how air pollution data can be analyzed quickly and accurately and in an interactive way, freeing time to consider the problem at hand. One of the major advantages of openair is the use of plots, which greatly increases accuracy. Finally, some consideration is given to future developments.

#### Applications

- It graphically displays the environmental data.
- It is used to plot probability distributions.
- It is also used to estimate distribution parameters and construct confidence intervals on the original scale for commonly used distributions such as the lognormal and gamma, as well as do this non-parametrically
- It also estimates and constructs confidence intervals for distribution percentiles. (e.g., to compare to an environmental protection standard)
- It is used to perform and plot the results of goodness-of-fit tests.
- Compute optimal Box-Cox data transformations.
- compute prediction limits and simultaneous prediction limits (e.g., to assess compliance at multiple sites for multiple constituents)
- Perform non parametric estimation and test for seasonal trend (even in the presence of correlated observations).

#### 3. Simapro

Life Cycle Assessment (LCA) Analyses and comparisons of product, process, and services according to the ISO standard covering the whole life cycle from the production of raw materials to end of life. SimaPro is the professional tool you need to collect analyses and monitor the sustainability performance data of your company's products and services. The software can be used for a variety of applications, such as sustainability reporting, carbon and water foot printing, product design, generating environmental product declarations and determining key performance indicators.

#### Applications

- It easily model and analyses complex life cycles in a systematic and transparent way.
- It also measures the environmental impact of your products and services across all life cycle stages.
- It identifies the hotspot in every phase of your supply chain from the extraction of raw materials to manufacturing, distribution, use, and disposal.

#### 4. SewerGem

SewerGem is provided sufficient time for solving wastewater engineering problems, such as improving capacity and limiting sewer overflows, which ultimately enable utilities to comply with sewer regulations set by regulatory agencies. To plan, design, maintain and operate sewer system SewerGem are provided engineering tools.

#### Applications

- Runoff flows are computed using the most appropriate runoff method for the project.
- SewerGem manage your model effectively so that you can focus on making the best engineering decisions.

## **5. WaterGEM**

WaterGEMS provides you with a complete easy-to-use decision-support tool for water distribution networks. The WaterGEM software helps improve knowledge about how basic structure behaves as a system and reacts to operational strategies. At different stages of environment, WaterGEMS can be used.

### **Applications**

WaterGEMS provides numerous software tools for:

- WaterGEMS are helping to identify potential problem areas, accommodate service area growth and plan capital improvements.
- Realistically modeling the operation of complex water systems can be difficult.

## **6. EPANET**

EPANET is a water distribution system software. It is designed to be "a research tool that improves our understanding of the movement and future of drinking-water constituents within distribution systems" EPANET first introduced in 1993. EPANET 2 is work as both a standalone program and as an open-source toolkit. It is used by many software companies.. The EPANET input file format, which represents network topology, water consumption, and control rules, is supported by many free and commercial modeling packages. Therefore, it is considered as the industry standard.

### **Applications**

- It is used to design of sampling programs.
- It helps to evaluate alternative strategies for improving water policy.
- Modify pumping and tank filling or emptying schedules to reduce water age
- EPANET is used to plan and improve systems hydraulic performance.
- It can be used for energy minimization and fire flow analysis.
- It can also be used for operator training.

## **7. Cantera**

Cantera is a software for problems including fluid mechanics, thermodynamics, and transport processes. It can be used to obtained chemical equilibrium, to get thermodynamic and transport properties of mixtures, to compute species chemical production rates, to model non-ideal fluids.

### **Applications**

- Cantera is using it for exploratory calculations, by writing few lines of code you can get a quick answer.
- Cantera is using it in teaching courses in combustion, reaction engineering, transport processes, kinetics or similar areas.
- Run simulations with your own kinetics, transport, or thermodynamics models.
- Make reaction path diagrams and movies.
- Create stirred reactor networks.
- Simulate multiphase pure fluids.

## **8. CivilStrom**

CivilStorm is a fully dynamic, hydraulic modelling solution. It is developed for the study of complex storm water systems. It is requisite to detect system bottlenecks, to improve capacity and limit storm water flooding. Civil Storm performs a study of all aspects of storm water systems such as rainfall, pressure piping, outlet structures, open channels, culverts and more.

### **Applications**

- This software analyses the pressure and free-surface flow conditions for networks of channels & closed conduits.
- With the help of software by data entry it manipulates the data and gives a simplified modelling solution.
- CivilStrom software recommends the most effective pipe sizes and inverts elevation while meeting design restriction.

## **9. StormCAD**

StormCAD is a hydraulic modeling software for the design and study of the storm water sewer system. It's easier to analyses storm sewer system from the gutter to the outlet, stormCAD calculates the actual catchment runoff, gutters, inlets, junctions, pipe networks, and outfalls.

### **Applications**

- Software allocates and estimates storm water whether it is going to be stored or runoff flows through the roads, culverts.
- The software analyses the inlet capacity of runoff which can enter an inlet versus proportion that can be carried downstream in a gutter or pond on the road surface.
- Software built and manage hydraulic models effectively.

## **10. WEAP**

WEAP (Water Evaluation and Planning) is a user-friendly software, use in the water resource planning's. WEAP software is very useful in growing numbers of water professionals to be useful for models, databases, spread sheets & others.

### **Applications**

- It provides a system for maintaining water demand & supply information.
- This software generates a scenario by simulating water demand, supply, runoff, stream flow, storage, pollution generation, etc.

## **11. WaterCAD**

Utilities and engineering firms around the world trust WaterCAD as a reliable decision support tool for their infrastructure. This is useful for plan, design and operates water distribution systems. It helps to improve design productivity and to supply clean potable water without interruption.

### **Applications**

- It allocates the water demand, terrain extraction, and node location.
- It allocates water and diverted to an emergency condition.
- It identifies the water loss.

## **12. Geopro**

It is a software package generally used for data interpretation and manipulations of exported raw data files. It also includes the Microsoft excel spread sheets programs and specialized geological graphs. There is a major need of software application which enables data sharing for better understanding, as a different database is used by the different application which create a problem in communication Geopro have a common layer between application and actual data storage due to which all applications in GeoPro system communicate with any other database.

### **Geopro consist of four main sections for working:**

- Data integration
- Quantitative analysis
- Isotope ratio
- Mapping

## **13. Geo-slope**

GeoStudio software suite is supported, developed and marked by GeoSlope International ltd which allows geotechnical and geo-environmental modeling. Geo-slope created a software which is technically very efficient to use, making geotechnical modeling easy and practical for all geotechnical engineers as per their object which set them as the industry standard in the geo-technical and geo-environmental engineering field.

### **Key features of GeoSlope:**

- It can define pore water pressure by piezometric lines, spatial functions.
- Rapid draw down analysis can be found out by pore water pressure.
- It supports an efficient range of various material models.
- Limit state design is supported.

### **Applications**

- For soil and rock slopes it is leading software which analyses both simple and complex problems for various loading conditions, slip surface shape, pore water pressure conditions, and soil properties.

## **14. PLAXIS**

Plaxis 3D is a package for three dimensional analysis of deformation and stability in geotechnical engineering and rock mechanics which is powerful and user-friendly as well. Top engineering companies, institutions, and industries using the plaxis 3D for various operations like excavation, embankment, tunneling, mining and reservoir geomechanics. It is easy to use as one can work with it after few hours of training.

### **Key Benefits of Plaxis**

- The most advance tool available in the market.
- Enables easy complex modeling.
- Makes the finite model creation fast and efficient.
- Contains a variety of advance soil models.
- It is user-friendly.

## 15. FLAC

Flac is for engineering mechanics computation by two dimensional explicit finite difference program. This program inspired by the behavior of structures built of soil, rock and other material which may undergo by plastic flow when yield limit is reached. It contains of the grid which can be adjusted by the user to fit modeling object. Flac ensures that plastic collapse and flow are modeled very accurately by using the explicit, langrangian calculation scheme and mixed discretization zoning technique. Large two dimensional calculations can be made without excessive memory requirement because no matrices are formed.

### Applications

- It is a general design and analysis tool for geotechnical, civil and mining engineering and can be used to the broad range of engineering problems.
- It is ideally suited for modeling multistage geomechanical problems such as sequential excavation, backfilling and loading because of explicit finite difference formulation.

## 3. CONCLUSION

Software's are the mediums or tool for any intended work in any type of project. There are a lot of companies globally available which provides a number of software's software suits to give the accurate and efficient solution to the complex engineering problems in less time.

The main purpose of this paper is to present great development in the contribution of software's which are helpful to work efficiently and accurately in an environmental and geo-environmental engineering discipline. Recent development in technology and competition in global software's market more user friendly, effective, flexible and better suited software's are available which provides ease in complex geo-technical and environmental modeling. Software's are contributing more for reducing the overall cost of the project with high efficiency and accuracy.

## 4. SCOPE OF WORK

Environmental engineering software's are the software's which helps engineer to plan, implement and execute any kind of project or work without facing any problems and if any then to eliminate them. Software's are used for a design of treatment processes and for evaluation of transport and transformation phenomenon of various pollutants such as air, water, and sewage. They can also serve as powerful tools in environmental engineering programs for problems that have various levels of complexity.

Following is the scope of work:

- Studying about the modern software's which are implemented in countries all around the globe for doing different works in environmental engineering.
- A site visit to nearby companies to get an overview of the currently available software's and to incorporate from it and to suggest some new techniques.
- If this software's knowledge is given to under graduate students by introducing in their syllabus, it would be very beneficial to them.

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