Concrete mix design using Java Eclipse IDE

*V.*SP Raju[1],*Aitha S*ai Teja[1],*D.*Ragnesh[2]*and M* Ajay Sagar[1]

[1]Department of Civil Engineering, GRIET, Hyderabad

Abstract. Concrete mix design is the process of selecting the proper components and figuring out the proper ratios to achieve the desired workability, strength, and durability. As a result, an attempt has been made to create a Java program for concrete mix design by IS 10262:2019 and IS 456:2000. Computer software is created in this way to proportion input variables to a set of output variables, which avoids time-consuming computations in real time. The produced program was carefully checked. The results were compared to make sure they were accurate after being put through a series of manually check issues. The concrete mix design produced by the Java program was exact, time-saving, and computationally efficient.
Keywords. Concrete, JAVA Programming, IS 456:2000. IS 10262:2019, Concrete Mix Design, Eclipse IDE.

1 Introduction

Concrete is a composite material made up of several distinct ingredients mixed in various proportions. The standard of the concrete may be impacted by these chemicals' characteristics. To produce concrete that is affordable, strong, workable, and long-lasting, concrete mix design aims to not only identify the appropriate components, such as cement, aggregates, water, and admixtures, but also calculate their relative proportions. Therefore, Concrete Mix = Cement: Sand: Aggregates is the formula for calculating the appropriate concrete mix. The concrete mix design process involves a variety of steps, calculations, and laboratory testing to establish the appropriate mix proportions. This technique is frequently employed for large construction projects that require a substantial volume of concrete as well as for structures that need higher grades of concrete, such as M25 and above. The materials used in the project such as Cement, Fine Aggregates, Coarse Aggregates, Water, Fly Ash, GGBS, Silica Fumes, Plasticizers etc,.

1.1 Ordinary And Standard Grades Of Concrete

The M10, M15, and M20 grades of concrete are considered to be standard. (For example, 3 Grades) M25, M30, M35, M40, M45, M50, M55, and M60 are common grades.

1.2 High Strength Grades Of Concrete

High strength grades of concrete refer to concrete mixes that have a compressive strength of 50 MPa (megapascals) or higher. High-rise buildings, bridges, and other structures requiring exceptional strength and durability frequently use these concrete mixtures.

2 Literature Review

Designing proper HPC mixtures is a difficult process because HPC is produced using a variety of chemical compounds with varying specifications and performance characteristics. The goal of this project is to build a unique artificial intelligence-assisted system to efficiently reduce the cost of creating HPC with varying compressive strength, workability, and durability requirements. (Min-Yuan Cheng and et al 2023). The effects of various materials on the characteristics of lightweight aggregate concrete during mix design and preparation are summarised. First, by varying the mixing ratio between the components, particle size gradation, and adding fibre, the performance of concrete's characterisation is improved. Also, the2rocessses of feeding and mixing the aggregate uniformly, as well as the forming mode, are summarised in the manufacture of concrete. (Jingyu li 2023). This paper investigated several mix designs for UHSC using traditional manufacturing techniques and widely available raw ingredients. An empirical equation for predicting the elastic modulus of UHSC was also developed using the experimental database recently compiled from up to 3000 tests with the cylinder compressive strength in the range of 100 Mpa to 200 Mpa. Comparing the proposed equation to existing equations and equations from current design codes shows that it is not only simple but also provides the most accurate predictions. (Tan-Trac Nguyen 2021). This study looks into selecting the ideal concrete mix to obtain the desired mean strength. Based on the IS:456-2000 and IS 10262-2019 standards, 43 grades of ordinary Portland cement, sand, and aggregate were chosen for this research project in order to calculate the amounts and ratios for concrete with the grade M25. The specimen was evaluated at 7 and 28 days into the curing phase and had a size of 150mm x 150mm x 150mm. (Abdul Aziz and A Ramakrishnaiah. (2019)). In a difficult, multi-step process called concrete mix design, we look for the ideal ratio of elements to produce concrete with high performance. There are various techniques for designing concrete mixes, however The Three Equation Method-based techniques are the most widely used. Compressive strength, which establishes the concrete class, is one of the most significant characteristics of concrete. The predictable compressive strength of concrete is essential for concrete structure utilization and is the main feature of its safety and durability. Recently, machine learning is gaining significant attention and future predictions for this technology are even more promising.(Dr. Patryk Ziolkowski and et al 2019)**.** In this paper proportion of Ingredients and the comparison of various ratios, i.e. Amount of cement, water-cement ratio, and total aggregate content by using IS, ACI, and BS methods were studied. The mixes created using the IS method and ACI approach met the desired mean strength, demonstrating the consistency of these procedures.(Kunal Bajaj And Sameer Malhotra (2018)). Designing the concrete mix is crucial since it affects how well constructed concrete structures perform. Common, mixed design is done by hand or developed excel sheets. These methods can be risky and take a long time, therefore is a need for an alternative time effective method. The programme for concrete mix design of high-strength concrete (HSC) built using a MATLAB programme is presented in this work. The final results obtained using the program match the results obtained using a manual approach. It was also noted that the computation time using the program was faster compared to the manual approach(Makenya A. R, John Paul M 2017).

3 Methodology

Empirical methods are used to determine SCC mix proportions. Using the results of earlier experiments, the link between input and output parameters is established. The results thus obtained can be tested by mixing concrete using the forecasted input values. From the obtained relationship, it is possible to forecast input parameters necessary for desired output values.

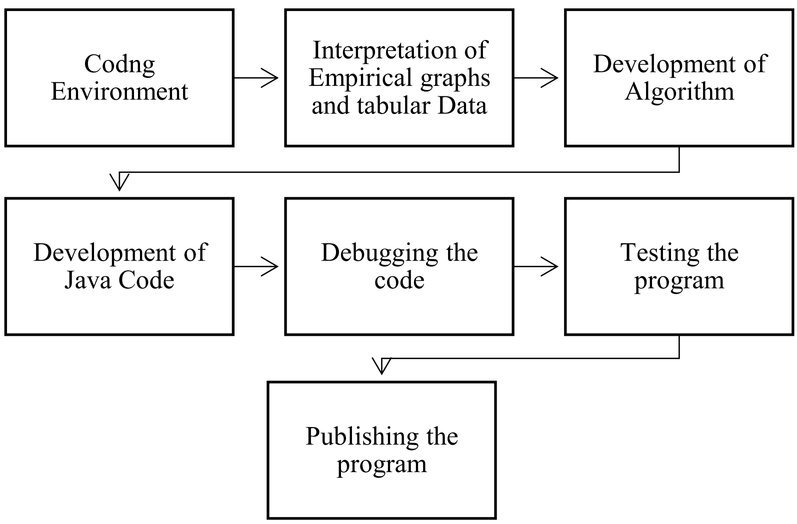

Fig. 1. Methodology

3.1 Source Code

The project source code is uploaded in the GitHub, to view the source code Click Here.

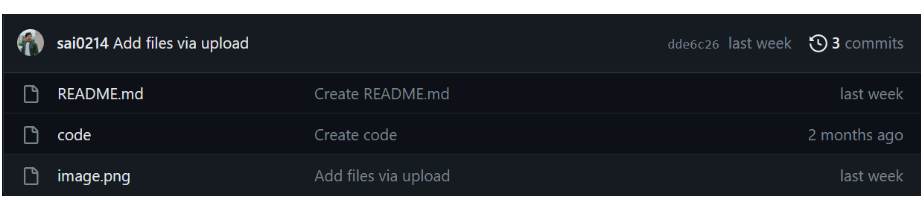

Fig 1. Git Hub Project Source

On clicking there a window opens as shown above.

3.2 Mix Design Procedure

The Mix Design procedure, formulas and tables are taken from IS 456:2000 and IS 10262:2019.

4 Implementation using Java Eclipse IDE

The design of the Java ECLIPSE IDE is discussed in this portion of the article with the help of a Java file that is described in the concrete mix design
The embedded development environment used for computer programming is called Eclipse. It has a basic workspace as well as an extensible plugin system to customize the environment. For Java Development, it is the 2 nd largest popular development IDE. The front end of Eclipse IDE has two panels; an Execution section an input section, output section. The Execution section involves the background code related to all the input-taking parameters, calculations, tables and display statements. Each of the user-initiated parameters, including concrete grade, maximum nominal size of concrete, fine aggregate zone, slump, and specific gravities, are included in the input section. The run button fetches ask for inputs and using the Execution section internally all the calculations are executed and the desired output is displayed. The output section displays the result in two different ways: first, in significant measure (in kilograms or liters), and second, in the form ratios concerning cement.

4.1 Ordinary And Standard Grades Of Concrete

4.1.1 Example 1

Input Section

Taken from Eclipse IDE.
After clicking the run button a window opens and displays then we should enter the required data to get the output.

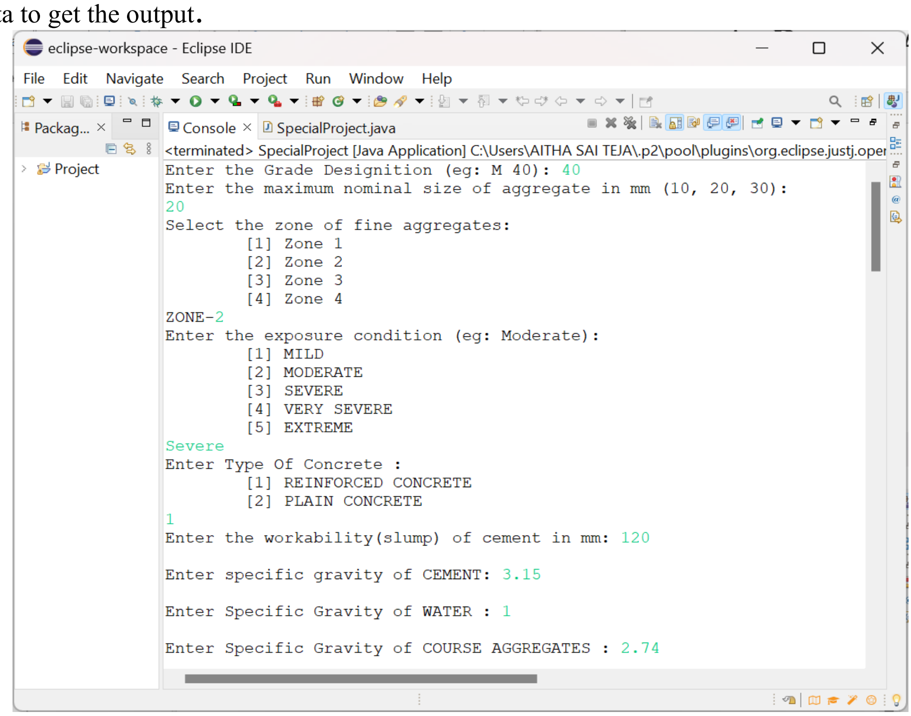

Fig 2(a). Input For Ordinary And Standard Grades Of Concrete

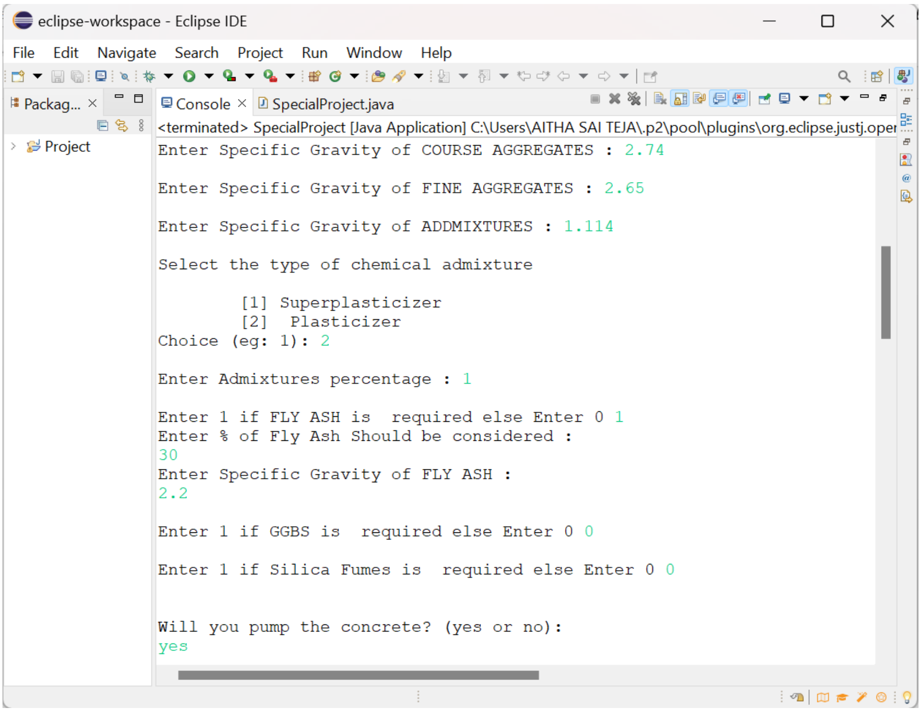

Fig 2(b). Input For Ordinary And Standard Grades Of Concrete

Output Section

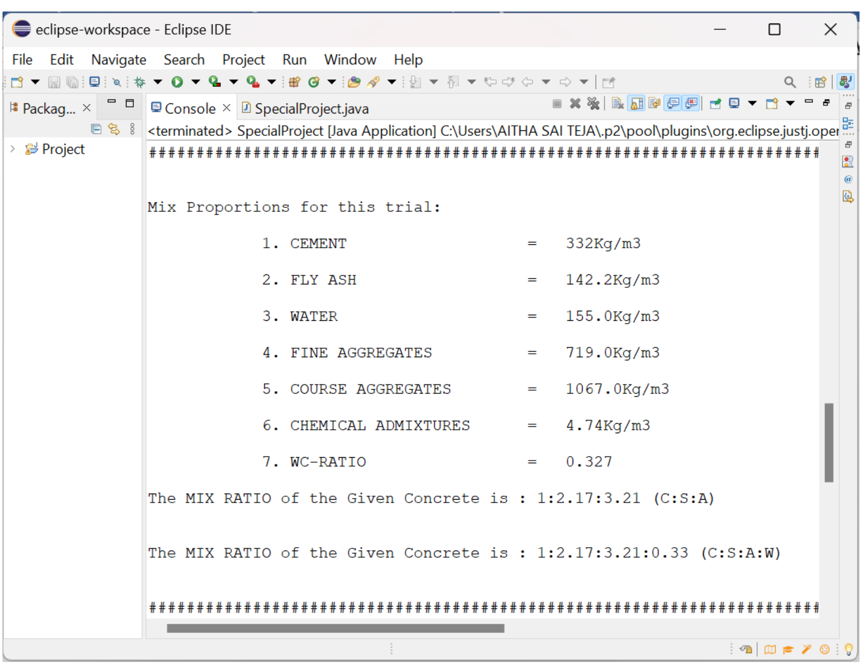

Fig 3. Output For Ordinary And Standard Grades Of Concrete

4.2 High Strength Grades Of Concrete

4.2.1 Example: 1

Input Section

Taken from Eclipse IDE.
After clicking the run button a window opens and displays then we should enter the required data to get the output.

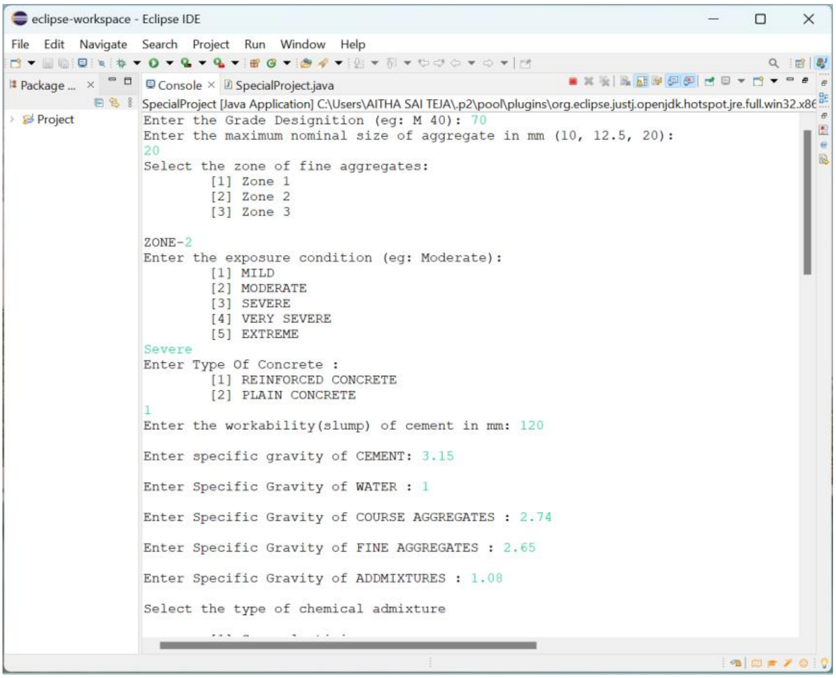

Fig 4(a). Input For High Strength Grades Of Concrete

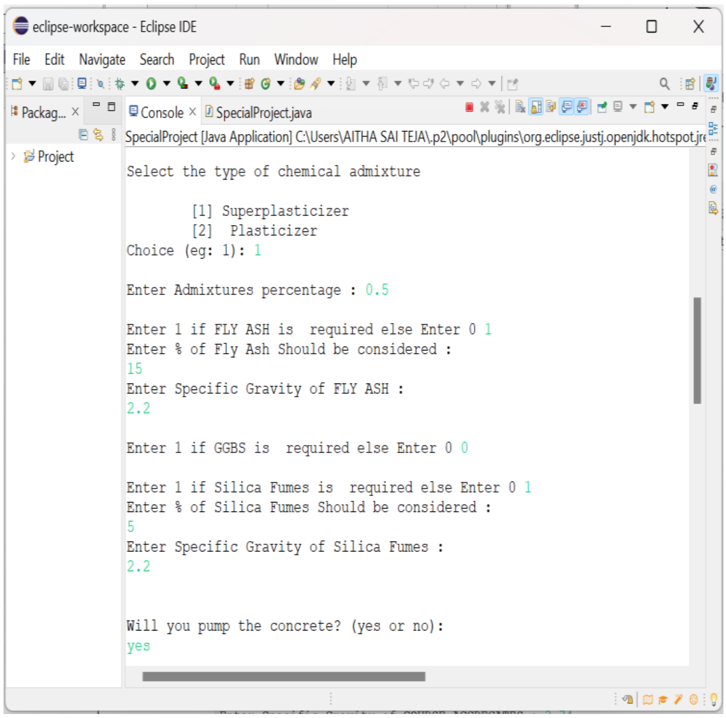

Fig 4(b). Input For High Strength Grades Of Concrete

OUTPUT SECTION

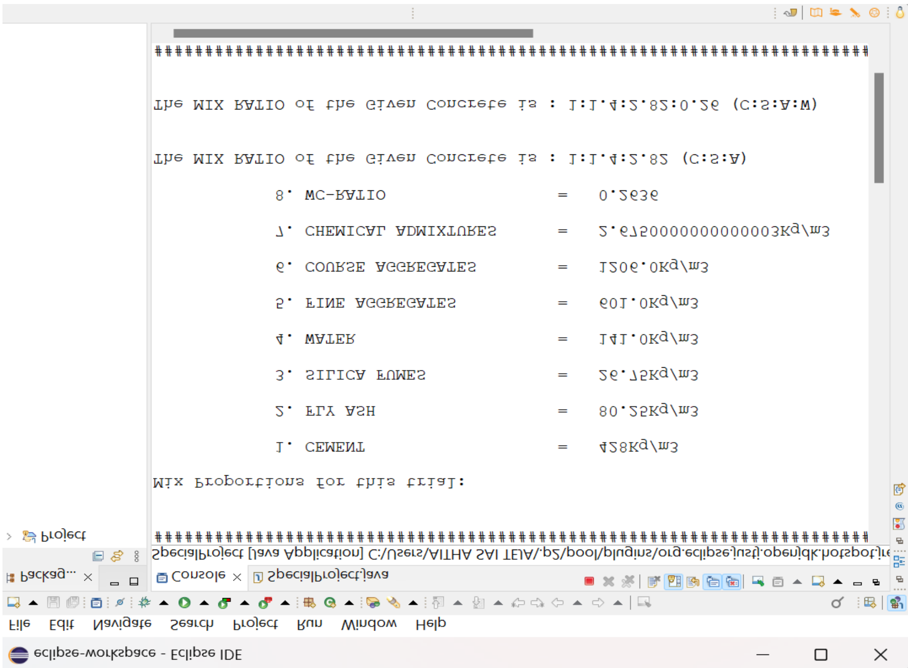

Fig 5. Output For High Strength Grades Of Concrete

5 Discussion of Test Results

The results obtained for Ordinary and Standard Grades of Concrete and High Strength Grades of Concrete is compared with manual calculation and also with IS 10262:2019. The results accurately matched with the manual calculation and standard code results.
Example1 and 2 are taken from IS 10262:2019 i.e., ANNEX B and ANNEX D. The obtained results are compared below.

Example 1: Ordinary And Standard Grades Of Concrete

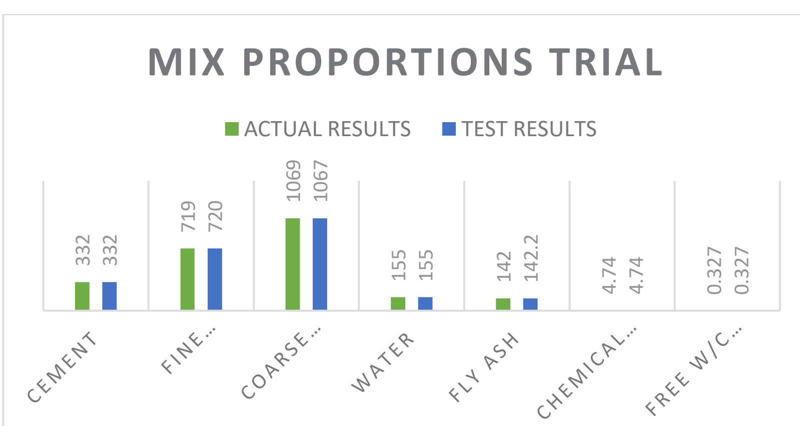

Fig 6. Graphical Representation for Ordinary And Standard Grades Of Concrete

- Green – Actual Results
- Blue – Test Results

Example 2: High Strength Grades Of Concrete

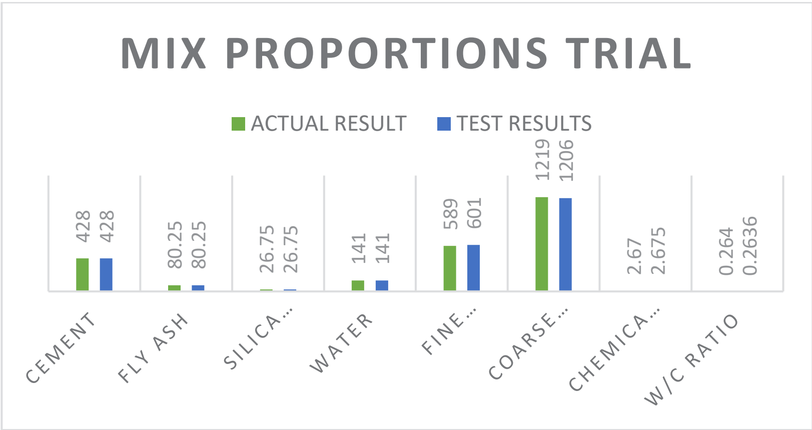

Fig 7. Graphical Representation for High Strength Grades Of Concrete

- Green – Actual Results
- Blue – Test Results

6 Conclusion

This paper described the step-by-step procedure used in the Java file designed in the ECLIPSE IDE to design the concrete mix for various concrete grades in conformance with IS standards. The results of the experiment and the manually obtained results are then evaluated. It has been found that the accuracy of quantities obtained using the virtual model of ECLIPSE IDE is higher than that of manual computation because ECLIPSE IDE doesn't omit the extremely tiny values up to the fourth decimal place or above. As a result, the quantization error i.e., the error involved in calculation due to rounding off the values reduces, and as a result, the quantum of coarse and fine total needed to mix the concrete is reduced by0.5 to 1 kg when compared to manually calculated results.
This demonstrates how ECLIPSE IDE was able to attain the highest level of accuracy. Also, using the ECLIPSE IDE considerably reduces the time needed to create concrete mixes because it only takes a few button clicks to calculate concrete mix ratios as opposed to several steps of manual computation. Additionally, it is noted that ECLIPSE IDE provides data abstraction, meaning that the user only sees the program's front end while the backend program, which uses formulas, is completely hidden from view. As a result, there is no possibility of human error in cases where mistakes are made due to incorrect usage of the formula, improper use of the calculator, or any accidental errors that change the formula or parameters, etc.

References

1. Concrete Mix Design, Quality Control and Specification, Fourth Edition (Ken W. Day, James Aldred, Barry Hudson)
2. Min Yuan Cheng “A novel artificial intelligence aided system to mine historical high performance concrete data for optimizing mixture design” , Taipei 10607, Taiwan-2023.
3. Jingyu Li “Research Status of Mix Design and Preparation of Lightweight Aggregate Concrete”, International Core Journal of Engineering 2023.
4. Review on the application of supplementary cementitious materials in self-compacting concrete L Pang, ZLiu, D Wang, M An - Crystals, Accepted:24 January 2022 / Published: 26 January 2022
5. Assessment of Mix Design for Government Project M. V. Bhirud and P. P. Bhangale,“Assessment of Mix Design for Government Project”, IJRESM, vol. **5,no. 5**, pp. 75–77, May 2022.
6. Srinivasa Reddy, V., Seshagiri Rao, M.V., Shrihari, S., International Journal of Engineering and Advanced Technology, 8(6), pp. 1661–1665 (2019)
7. Srinivasa Reddy, V., Seshagiri Rao, M.V., Shrihari, S., International Journal of Recent Technology and Engineering, 8(2), pp. 2125–2130 (2019)
8. Kumar, K.S.J., Seshagiri Rao, M.V., Reddy, V.S., Shrihari, S.. E3S Web of Conferences, 184, 01076 (2020)
9. Srinivasa Reddy, V., Krishna, K.V., Rao, M.V.S., Shrihari,. E3S Web of Conferences, 309, 01058 (2021)
10. Reddy, V.M., Hamsalekha, S., Reddy, V.S. AIP Conference Proceedings, 2358, 080018 (2021)
11. Reddy, V.S., Satya Sai Trimurty Naidu, K., Seshagiri Rao, M.V., Shrihari, S.. E3S Web of Conferences, 184, 01082 (2020)
12. Use of Artificial Intelligence for Predicting Parameters of Sustainable Concrete and Raw Ingredient Effects and Interactions MN Amin, W Ahmad, K Khan, A Ahmad, S Nazar Accepted: 18 July2022 / Published: 27 July 2022.
13. Machine Learning Techniques in Concrete Mix Design by (Dr. Patryk Ziolkowski)
14. CONCRETE MIX DESIGN AND OPTIMIZATION Genadij Shakhmenko1 and Juris Birsh2 Riga Technical University, Department of Building Materials Azenes str. **16**, LV 1658.
15. de Larrard, Francois, and Thierry Sedran. "Computer aided mix design: predicting final result." Concrete International 18, no. 12 (1996): 39-41.
16. Srinivas. T, Abhignya. G and Ramana Rao. N.V, , E3S Web of Conferences, ICMED, 10-12 July 2020, India (2020).
17. T.Srinivas and G. Sukesh Reddy, International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Volume-9 Issue-1 (October-2019), PP 2301-2304.
18. T.Srinivas and R. N. Koushik, International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8 Issue-12 (October-2019), PP 112-117.
19. K. Sai Gopi, Dr. T. Srinivas and S. P. Raju V, E3S Web of Conferences ICMED 184, 01084(2020), GRIET, 28-29 February, https://doi.org/10.1051/e3sconf/2020184011084.
20. T.srinivas and P. Manoj Anand, “, International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8 Issue-12 (October-2019), PP 2987-2990.Makenya A. R., John PaulM., 2017. Potentiality

of Using a DevelopedMatLab Program for the Design of High Strength Concrete Mixes, Journal of Civil Engineering Research, **7**(3), pp.81-98
21. T. Sedran, F. de Larrard, BetonlabPro 2, Computer Aided Mix Design Software published by Presses de l'Ecole Nationale des Ponts et Chaussées, 28 rue des Saints-Pères, 75 007 PARIS, France, 2000.