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Web based – Modern Concrete Mix Design

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***Abstract*— Consisting of cement, water, fine and coarse aggregates, and occasionally chemical admixtures, concrete is a composite material that is frequently employed in construction. Concrete mixture design is essential for guaranteeing the cost-effectiveness, durability, and strength of structures. In order to attain the required mechanical properties and workability, this project concentrates on the development of an optimal cement concrete mixture design that is based on scientific principles and practical guidelines. This project's objective is to ascertain the appropriate proportions of the various components by considering factors such as compressive strength, water-cement ratio, aggregate grading, and environmental exposure. A variety of combination design methods, including the Indian Standard (IS) method, are investigated and implemented during the design process. In order to assess the efficacy of varied concrete mixes, laboratory testing is implemented, which encompasses compressive strength and slump tests. Moreover, this project addresses the obstacles encountered in the development of a sustainable and cost-effective mix design, with an emphasis on the reduction of cement consumption by incorporating alternative materials, such as slag or fly ash. This endeavor will yield valuable insights into the optimization of concrete mixtures for specific construction requirements while minimizing environmental impact.**

***Index Terms*— Concrete mixture design, compressive strength, water-cement ratio, aggregates, sustainability, durability.**

I. INTRODUCTION

In modern construction, the strength and durability of structures are significantly dependent on the quality of the cement concrete mixture. Proper mix design is critical to attaining the desired properties of concrete for various construction applications. This project seeks to develop a web application that simplifies the process of designing optimal concrete mixes.
The core feature of this web app is a custom calculator that allows users to input key parameters and receive accurate mixture recommendations tailored to enhancing concrete strength.
The web application is designed to assist civil engineers and construction professionals determine the ideal proportions of cement, aggregates, water, and additives to achieve specific strength requirements. By automating the calculations and providing user-friendly interfaces, the app ensures that the mix design process is efficient, accurate, and accessible to both experienced professionals and newcomers in the field. This project also explores how various ratios and components can influence the performance of concrete, offering practical solutions for improving structural integrity.

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II. Purpose Of Project

- Simplify complex calculations: Provide a user-friendly interface for performing intricate civil engineering calculations, making them accessible and manageable for professionals and students.
- Accessibility: Make complex calculations accessible on various devices for on-site use by field engineers, contractors, and construction managers.
- Informed decision-making: Support construction professionals in making informed decisions based on accurate data.
- Enhance efficiency and productivity: Streamline the workflow for civil engineers by reducing the time and effort required to perform complex calculations, thereby increasing overall productivity.

III. Literature Review

S. A. Patil and D. Desai, "Optimization of Concrete Mix Design Through Web Application Using AngularJS and Node.js," Journal of Advanced Research in Civil Engineering, vol. 12, no. 5, pp. 89–95, 2018.This paper presents a web application for optimizing concrete mix design, incorporating modern web frameworks such as AngularJS for the frontend and Node.js for the backend. The application seeks to streamline the mix design process and improve accessibility for engineers working in the field. The study shows significant improvements in productivity and accuracy when using the web-based system. A. Kumar and R. Singh published "Cloud-Based Concrete Mix Design Application: Accessibility, Scalability, and Storage Advantages" in the Journal of Construction Engineering and Management (Vol. 147, No. 6, p. 102105, 2021).This work presents a cloud-based online application for concrete mix design, highlighting its benefits in terms of data storage, accessibility, and scalability. The program uses cloud infrastructure to enable remote access to design tools and information, enhancing cooperation between engineers and project managers. Y. Wang and C. Lee, "Smart Concrete Mix Design System Using Machine Learning Techniques," Automation in Construction, vol. 118, p. 103276, 2020.In order to forecast the ideal mix proportions based on required strength and durability characteristics, this work presents a smart concrete mix design method that makes use of machine learning techniques. The system trains models that automatically suggest mix modifications using a database of prior mix designs and performance outcomes. The methodology, according to the scientists, dramatically increases prediction accuracy and cuts down on the amount of time needed for human trial-and-error techniques in traditional mix creation.

The article "Integrating Artificial Intelligence in Concrete Mix Design for Improved Compressive Strength Prediction" by M. Shah and K. Patel appeared in the Journal of Building Engineering in 2020, volume 31, page 101282.This study explores how artificial intelligence (AI) can be included into concrete mix design applications, specifically for forecasting concrete's compressive strength. To optimize mix proportions, the researchers employed machine learning technologies such as regression models and neural networks. The results demonstrate that AI may improve concrete property prediction accuracy while reducing the need for trial-and-error, which is advantageous for web apps that concentrate on mix creation.

IV. Problem Statement

To provide an intuitive web tool that makes complicated material concentration calculations easier for the civil engineering industry. It will automate calculations to remove human mistake and guarantee quicker, more precise construction project outcomes.

V. Objective of Project

- To design a comprehensive computer technology;
- To perform concrete mix proportioning digitally using a modern computer technology;
- To design a web application for widespread use;
- To analyze the con mix design—a diversified proportioning using table graphs and databases

VI. Scope of the Project

The project entails creating a web application that uses a concrete mix and enables users to enter parameters to generate the best mix designs for a range of building requirements. It will assist experts in figuring out the ideal ratios of cement, aggregates, water, and additives to increase the strength of concrete. The program can handle various design specifications, is scalable, and can be expanded to include more features like sustainability measures and material cost estimation.

VII. SYSTEM DESCRIPTION

Here is the system description for the cement concrete mixture design project based on the given flowchart:

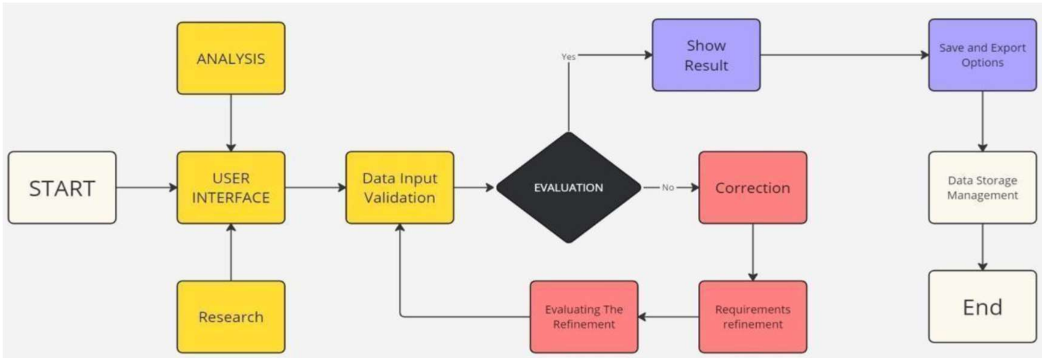

Fig 1: Flowchart of Concrete mix design proportion

A. Start

The system starts up, getting ready to lead the user through the design process of the cement concrete mix.

B. User interface

Serves as the main means of communication between the user and the system.
Function: Shows input field options where users can enter concrete mix parameters such material types, ratios, and environmental conditions.

C. Analysis

Goal: Helps decompose user inputs into variables required for the computation of the concrete mix.
Function: This module examines the data for durability, material strength, and other combination specifications.

D. Research

Goal: Examines pertinent references, standards, and specifications to make sure the mixture design complies with industry requirements.
Purpose: Offers recommendations, advice, or prompts based on concrete mix design specifications, such as those issued by IS or ASTM.

E. Validation of Data Input

Goal: Verifies that data supplied by users is accurate, comprehensive, and falls within reasonable bounds.
Function: Verifies the entries to identify any mistakes or discrepancies. For example, it could determine whether the ratio of cement to water is practical for the required strength.

F. Evaluation

Goal: Confirms that the mix design satisfies the desired requirements.
Function: The system determines the viability of the mix design based on the verified data. Results are displayed if the design satisfies all requirements; if not, a correction loop is started.

G. Correction

Goal: Offers input and permits iterative improvement of the mix design.
Function: This stage enables the user to fix input errors or modify parameters if the design does not match specifications.

H. Improvement of Requirements

Goal: Modifies requirements or specifications to enhance the final design.
Function: This module makes sure that the improved design complies with the required strength and durability by adjusting the parameters in response to input from the assessment step.

I. Assessing the improvement

Goal: Evaluate the improved design once more.

Function: The system reassesses the design once the adjustments are made to make sure all parameters now produce the intended results.

J. Show result

Goal: If all conditions are satisfied, it shows the final concrete mix design parameters.
Function: Displays information about the mix's expected performance, material specs, and proportions.

K. Options for saving and exporting

Goal: Enables users to export or save the completed design.
Function: Offers choices to print the results directly or save the design in several formats, such PDF or CSV.

L. Data storage management:

Goal: Arranges and saves finished design data for later use or examination.
Function: Provides version control and easy retrieval of designs by storing the mix design data in a database.

M. End

When the procedure is complete, the design is prepared for use by being saved, exported, or printed.

VI. DETAILS OF METHODOLOGY

Techniques for Creating an Online Application to Examine Concrete Mix Designs
To ensure accuracy, usability, and real-world applicability, this application was developed using a disciplined, multi-phase process. There were five main stages to the process:
Phase 1: Initial Manual Evaluation

- Analyzed the proportions of the concrete mix by hand.
- Examined pertinent literature and industry standards to get knowledge about material qualities and mix ratios.
- Determined important variables to compute, including the ratios of cement, water, aggregates, and admixtures.
- Developed a fundamental comprehension of the theoretical and empirical models applied to mix design analysis.

Phase 2: Development of the front end

- Using HTML, CSS, and JavaScript, an intuitive and responsive interface was created.
- Enabled users to examine mix results in real time on the interface and enter values.
- Added real-time feedback to improve user experience and interaction by enabling users to dynamically view calculated outcomes.
- Guaranteed user-friendly navigation and cross-device compatibility for accessibility on many platforms.

Phase 3: Computational Backend and Logical Implementation

- Used JavaScript to convert manual mix design principles into computational algorithms.
- Added features to compute volumetric ratios, material weights, and the water-to-cement ratio based on user input.
- Conditional logic was used to take mix grade criteria, slump requirements, and environmental elements into consideration.
- To facilitate future scaling and possible integration with additional data sources or APIs, modular, reusable functions were developed.

Phase 4: Validation and testing

- To verify correctness, application output was compared to manually estimated mix designs.
- Verified that the application's output complied with industry norms.
- Tested and improved iteratively to verify the dependability and effectiveness of the application.
- Field experts gathered user feedback, and logic and usability were modified appropriately.

Phase 5: Completion

- Confirmed that the program yields accurate, trustworthy, and easily obtainable results.
- Completed the application as a practical, effective tool for designing concrete mixes.

VII. SOFTWARE COMPONENTS

Components of project software:

Front-end technologies:

- HTML: Used to arrange the structure of the online application, give users input forms, show results, and make sure the layout suits user requirements.
- CSS: This helps create user-friendly and responsive interfaces for online applications, allowing for a clean and navigable appearance.
- JavaScript: Enhances the frontend with logic and interaction. For a smooth user experience, JavaScript gathers input, performs computations, and dynamically refreshes the interface.

Tools for development:

IDE or Code Editor: Programs such as Visual Studio Code facilitate effective coding by offering capabilities like debugging, syntax highlighting, and web development extensions.

VIII. Project Implementation

Following steps are used for implementation of system

A. Creating an HTML file

```html
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Concrete Mix Web app UI</title>
```

Fig 2

The project starts with creating an HTML File for project in VS Code (software Tool).

B. Importing CSS for UI

```html
<link rel="stylesheet" href="StyleUI.css">
<link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/4.7.0/css/font-awesome.min.css">
```

Fig 3

The main part of the project is its UI (user Interface) so CSS deals with UI.

C. Importing required fonts for UI

```html
<link rel="preconnect" href="https://fonts.googleapis.com">
<link rel="preconnect" href="https://fonts.gstatic.com" crossorigin>
<link href="https://fonts.googleapis.com/css2?family=Hind:wght@300;400;500;600;700&family
=Poppins:ital,wght@0,100;0,200;0,300;0,400;0,500;0,600;0,700;0,800;0,900;1,100;1,200;1,30
0;1,400;1,500;1,600;1,700;1,800;1,900&display=swap" rel="stylesheet">
```

Fig 4

Importing fonts for user interface one that is readable and comfortable to read is “poppins”.

D. The landing page of project

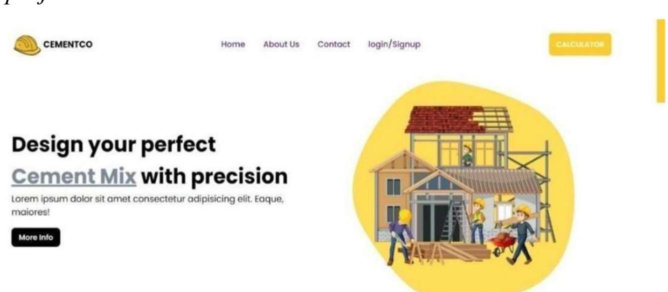

Fig 5

This page consist of main part that ‘Calculates the Mix proportion’

E. Sign In page of project

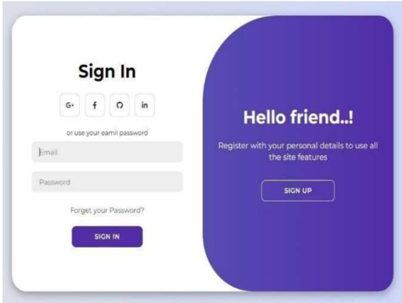

Fig 6

IX: PSEUDOCODE LOGIC

A. Get all inputs from user form

Collect inputs such as:

- Grade of concrete (e.g., M20, M25)
- Desired slump (workability)
- Water-Cement (W/C) ratio
- Specific gravities (SG) of cement, aggregates, SCMs, etc.
- Aggregate size
- Exposure condition
- Whether Supplementary Cementitious Materials (SCMs) or admixtures are used These are the base parameters required to start the mix design calculations.

B. If custom water content is given

- If user manually enters water content, use that value.
- Else, calculate based on: Slump value (higher slump = more water)
- Maximum aggregate size
- Admixture usage (e.g., plasticizers can reduce water requirement) Use IS 10262 tables to pick base water content and apply corrections.

C. Calculate Target Mean Strength

- Target Mean Strength = Characteristic Strength + Margin
- Margin is based on standard deviation (from IS codes) or empirical formulas:
- Target Strength = fck + (1.65 × S)

where: fck = characteristic strength
S = standard deviation based on grade (given in IS 10262 2019) This ensures the mix consistently achieves required strength.

D. Calculate Cement Content

Use the formula:
Cement = Water Content / W/C ratio
If SCM is used (like fly ash or slag), reduce cement accordingly:
Cement = Cement × (1 - SCM%)
SCM = Cement × SCM%
Also, ensure minimum cement requirement as per IS 456 based on exposure condition.

E. Calculate Volume Contribution

For 1 m^3 of concrete:

- Cement volume = mass / (SG × 1000)
- Water volume = mass / (1 × 1000) (since SG of water = 1)
- Admixture volume = (dosage% × cement) / (SG × 1000)
- SCM volume (if used) = SCM mass / (SG × 1000)

- ➢ Entrapped air = assumed from IS code (e.g., 2% for nominal max size)

This helps subtract the non-aggregate components from the total volume.

F. Compute Available Volume for Aggregates

Aggregate Volume = 1 m³ - (Cement + Water + Admixture + SCM + Air)
This gives you the remaining volume to be filled by fine and coarse aggregates.

G. Determine Volume Ratio of Fine/Coarse Aggregates

IS 10262 gives recommended values based on:

- ➢ Max size of aggregate (e.g., 10mm, 20mm)
- ➢ Fine aggregate grading (Zone I to IV)
- ➢ Water-cement ratio (to fine-tune workability)

Split the available volume into fine and coarse aggregate proportions.

H. Calculate Mass of Fine Aggregate

Fine Agg Mass = volume × fine ratio × SG × 1000

- ➢ Apply correction for water absorption if needed:

Adjusted Mass = Mass × (1 + Absorption %)

I. Calculate Mass of Coarse Aggregate

Coarse Agg Mass = volume × coarse ratio × SG × 1000
Apply similar correction for moisture or absorption.

J. Calculate Admixture Mass

Admixture = (Dosage % × Cement Content)
This gives the weight of admixture to be added to mix, useful for dosage monitoring.

K. Output all calculated values

Print or display:

- ➢ Cement (kg)
- ➢ SCM (if any)
- ➢ Water (liters)
- ➢ Fine Aggregate (kg)
- ➢ Coarse Aggregate (kg)
- ➢ Admixture (kg or liters)

These values represent the mix proportions for 1 cubic meter of concrete.

X. Result

Input field Page for calculation:

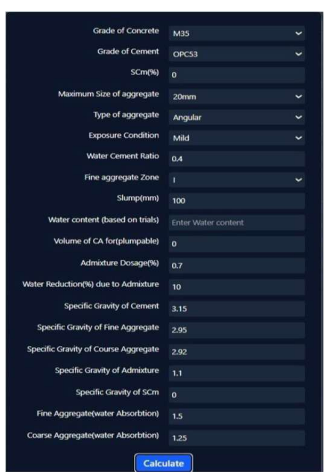

Fig 7

This is a Concrete Mix Design Input Form

TABLE I: GENERAL MIX DESIGN INFORMATION

Parameter	Value	Explanation
Grade of Concrete	M35	Characteristic strength of concrete = 35 MPa (or N/mm²) at 28 days. Target strength used was 43.25 N/mm², accounting for margin.
Grade of Cement	OPC 53	Ordinary Portland Cement, high strength, fast setting.
SCM (%)	0%	No supplementary cementitious materials (like fly ash, GGBS, etc.) used.
Maximum Aggregate Size	20 mm	Standard size, suitable for most reinforced concrete work.
Type of Aggregate	Angular	Gives better interlocking and strength compared to rounded aggregates.
Exposure Condition	Mild	No aggressive chemical exposure. No special durability requirements.
Slump (mm)	100	Workability: moderate (suitable for pumping and placing manually).

TABLE II: WATER-CEMENT RATIO AND WATER CONTENT

Parameter	Value	Description
Water-Cement Ratio	0.4	Lower ratio improves strength & durability.
Admixture Dosage (%)	0.7	Superplasticizer dosage to improve workability.
Water Reduction (%)	10%	Due to admixture, 10% water reduction is assumed

TABLE III: MATERIAL SPECIFIC GRAVITY & ABSORPTION

Material	Specific Gravity	Water Absorption (%)	Use in Mix Design
Cement	3.15	-	For converting volume to mass.
Fine Aggregate	2.95	1.5 %	Impacts correction for moisture.
Coarse Aggregate	2.92	1.25%	Impacts bulk volume and water adjustment.
Admixture	1.1	-	Dosage = 0.7% of cement = 3.11 kg/m³

A. Calculated Results

Fig 8

When the concrete mix design web application was being developed and tested, the following results were noted:

Precise Calculation Results

- Using user inputs including target strength, water-to-cement ratio, specific gravities, and aggregate characteristics, the application produced accurate mix design results.
- Cement, water, fine and coarse aggregates, and admixture quantities were among the output values that closely matched the outcomes of calculations done by hand.

Real-Time Response

The tool offered a dynamic and interactive user experience by successfully displaying results instantly when users made changes to their inputs.

Validation with Industry Standards

The tool offered a dynamic and engaging user experience by successfully displaying instant results when users made changes to their input.

Cross-Platform Usability

The responsive design supported both on-site and academic use by ensuring seamless operation across a range of devices, including PCs, tablets, and cellphones.

Error Handling

By including input validation, default values, and warning messages for conflicting entries, the system successfully avoided computation errors.

B. Target Strength

43.25 N/mm² this value indicates the characteristic compressive strength of the concrete at 28 days. This is the designed strength that the concrete must achieve, typically based on structural requirements.

TABLE IV. MATERIAL QUANTITIES (PER CUBIC METER OF CONCRETE)

Material Type	Quantity (kg/m³)	Description
Cement	444	Quantity of Ordinary Portland Cement (OPC) or equivalent used in the mix.
SCm (Supplementary Cementitious Materials)	0	No fly ash, slag, or silica fume used in this mix.
Fine Aggregate	738.76	Sand or crushed stone smaller than 4.75 mm.
Coarse Aggregate	1196.3	Crushed stone or gravel usually larger than 4.75 mm.
Admixture	3.11	Chemical admixtures such as superplasticizers or water reducers.

TABLE V. MIX PROPORTION (BY WEIGHT RATIO W.R.T CEMENT)

Material	Ratio	Interpretation
Cement	1.00	Base material
Fine Aggregate	1.87	1.87 parts of sand per part of cement
Coarse Aggregate	2.98	2.98 parts of coarse aggregate per part of cement
Water Content	0.40	Water-Cement Ratio (W/C) = 0.4, a key indicator of workability and strength

These are normalized values indicating how much of each component is used per 1 part of cement:

From the above result we observed that the Water-Cement Ratio of 0.4 suggests a relatively low water content, which is typical for high-strength concrete and helps in achieving the target strength of 43.25 MPa. No SCMs are used — which could otherwise enhance long-term strength or durability. The mix uses a chemical admixture (3.11 kg/m³), likely for improving workability or setting time.

The aggregates dominate the volume (738.76 + 1196.3 = 1935.06 kg/m³), which is standard in concrete mixes. This is a high-strength concrete mix design optimized for strength and durability. The low W/C ratio and high cement content ensure good performance, possibly intended for structural members like beams, columns, or slabs in high-load conditions.

TABLE VI. FINAL OUTPUT MIX PROPORTIONS

Material	Value (kg/m³)	Ratio (w.r.t Cement)
Cement	444	1.00
Water	177.6	0.40
Fine Aggregate	738.76	1.87
Coarse Aggregate	1196.3	2.98
Admixture	3.11	0.007

This is a high-strength concrete mix (M35) suitable for structural applications, such as beams, columns, slabs, and precast elements. The low water-cement ratio ensures high durability, low permeability, and higher compressive strength.

Use of admixture (0.7%) helps retain workability (slump 100 mm) even with reduced water content. Well-balanced aggregate mix: Coarse (60%) and fine (40%) mix ensures good strength and finish.

XI. CONCLUSION

In summary, a major development in the method of concrete formulation is the concrete mix design web application. It fits the requirements of contemporary, data-driven project management and tackles major construction difficulties by offering a strong, intuitive, and effective solution.

Its benefits in accuracy, efficiency, and sustainability have the potential to transform industry practices and improve results for a wide range of stakeholders. This project makes a significant contribution to the field of civil engineering and is in line with the ongoing digital revolution of the construction sector thanks to its solid foundation and good prospects for future growth.

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