Pave Core-Thickness a Software Driven Approach

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ABSTRACT

India's rapidly expanding transportation infrastructure has created a growing need for efficient, durable, and standardized pavement design solutions. Flexible pavements, being the most widely adopted form of road construction, demand accurate design to ensure structural stability, cost-efficiency, and long-term performance. This research presents the development of a user-friendly software tool that automates the design of flexible pavement thickness in strict accordance with the latest IRC:37-2018 guidelines issued by the Indian Roads Congress.

The software is designed to assist highway engineers and planners by simplifying the traditionally complex and manual pavement design process. It accepts essential input parameters such as traffic loading (in million standard axles), subgrade CBR, lane configuration, and material properties, and intelligently computes the required thickness for each pavement layer—including surface course, base, and sub-base. The tool integrates IRC-specified design charts and algorithms to ensure accuracy and standard compliance.

Key features of the software include a graphical interface, automated design summary report generation, and optional modules for material estimation and cost approximation. These capabilities enhance the efficiency and accuracy of the design process while minimizing human error.

By bridging the gap between academic knowledge and field application, this project supports smarter, faster, and more reliable pavement engineering practices. The proposed software contributes significantly to standardized infrastructure development, helping engineers make informed decisions and improving the overall quality and durability of road networks across the country.

Keyword: - Flexible Pavement, IRC:37-2018, Pavement Design Software, CBR, Traffic Loading

1. INTRODUCTION

India's expanding transportation infrastructure requires efficient, durable, and cost-effective pavement designs, with flexible pavements being the most commonly used. While the *IRC:37-2018* guidelines offer a comprehensive approach, the traditional manual design process can be complex and prone to errors. This project addresses this challenge by developing a user-friendly software tool that automates the design of flexible pavement thickness in full compliance with the latest IRC guidelines.

The tool simplifies the design process by accepting key input parameters such as traffic loading, subgrade CBR, lane configuration, and material properties. It computes the required thickness for each pavement layer—surface, base, and sub-base—ensuring both accuracy and compliance with IRC recommendations

1.1 Objective of the Project

The primary goal of this project is to develop a software tool that automates the calculation of optimal flexible pavement thickness, improving accuracy and efficiency. The tool aims to simplify the traditionally complex and error-prone manual design process by integrating design standards from IRC:37 (2018, 2001). Key objectives include:

- Automation of Pavement Thickness Calculation: The software will automate the design process, eliminating the need for manual chart referencing and interpolation, thus speeding up the process and reducing human error.
- Accuracy and Speed: By using validated design algorithms, the tool will provide precise and quick results, even with large datasets or multiple design scenarios.
- User-Friendly Interface: The software will feature an intuitive GUI, ensuring accessibility for civil engineers, students, and researchers, with input validation, graphical output, and report generation options.
- Educational and Practical Utility: The tool will aid students in learning pavement design and assist researchers in testing new materials or traffic conditions, enhancing both educational and professional applications.

1.2 Scope of project

This project focuses on designing, developing, and implementing a software tool to calculate the optimal thickness of flexible pavements. The tool will apply standardized design methods from IRC:37-2001, 2012, and 2018 to create an efficient and reliable pavement design system for both professionals and students. Key elements of the project include:

- Application of Standard Design Guidelines: The software will follow the IRC:37 guidelines to compute layer thickness based on traffic loading and subgrade conditions.
- Input Parameter Handling: It will accept inputs such as cumulative standard axles (msa), subgrade CBR value, material properties, and traffic growth rate.
- Pavement Layer Thickness Calculation: The tool will calculate the thickness of pavement layers including granular sub-base, base course, and bituminous layer.
- User Interface and Accessibility: The project will feature a user-friendly graphical interface, allowing users to input parameters, view results, and export data in various formats.
- Target User Groups: The tool is designed for academic researchers and students learning pavement design.
- Error Reduction and Speed Optimization: Automation will minimize human errors and reduce time spent on analyzing multiple scenarios.

2. METHODOLOGY

This project focuses on developing software to calculate the thickness of flexible pavements based on the IRC:37-2018 guidelines and other relevant standards. The methodology follows a systematic approach, comprising data collection, algorithm development, software implementation, and validation. The goal is to automate the pavement thickness design process, enhancing accuracy and efficiency compared to traditional manual calculations. By leveraging established engineering principles, the software aims to simplify the design process while ensuring compliance with industry standards

2.1 Requirement Gathering and Mathematical Modeling

The software is designed based on the Mechanistic-Empirical (M-E) method, as per IRC:37-2018, 2001, which supersedes older empirical methods. This approach uses stresses and strains within pavement layers to determine the optimal thickness for durability and cost-effectiveness.
Layered Structure of Flexible Pavement
According to IRC:37-2018, 2001, a typical flexible pavement consists of the following layers:

- Bituminous Surface Course (Asphalt)
- Granular Base Layer (WMM or DGA)
- Granular Sub-base Layer (GSB)
- Subgrade (Natural or Compacted Soil)

2.2 Input parameters

The software considers key input parameters as per IRC:37-2018 guidelines, including:
Traffic Loading Parameters (ESAL Calculation)
Traffic loading is expressed in Equivalent Single Axle Load (ESAL), which standardizes axle loads to an 80 kN axle. The ESAL is calculated as:
ESAL=∑(Ni×Fi)\text{ESAL} = \sum (N_i \times F_i)ESAL=∑(Ni×Fi)
Where:

- N_i = Number of axles in a specific load category
- F_i = Load equivalency factor from IRC:37-2018

Additional factors considered:

- Design Life (years)
- Traffic Growth Rate (%)
- Initial Traffic Volume (CVPD - Commercial Vehicles Per Day)

The software also calculates the Cumulative Standard Axles (CSA) using the formula:
CSA=365×A×[(1+r)n−1r]×D\text{CSA} = 365 \times A \times \left[\frac{(1 + r)^n - 1}{r} \right] \times DCSA=365×A×[r(1+r)n−1]×D
Where:

- A = Initial traffic volume (CVPD)
- r = Annual traffic growth rate (decimal)
- n = Design period (years)
- D = Directional distribution factor

These calculations help determine the impact of traffic loading over the pavement’s lifespan, ensuring a durable and effective design.

2.3 Software Development & Implementation

This phase of the project focused on converting the pavement design logic derived from IRC:37 into a functional, user-friendly software application. It involved selecting appropriate technologies, designing the system architecture, developing the user interface, and implementing the backend logic for pavement thickness calculation. The development process ensured that the software would be fast, accurate, and easy to use for civil engineers, students, and researchers.

3. RESULT

3.1 By manual method

- Number of lanes: Two-lane single carriageway
- Initial traffic (in year of completion): 400 CV/day
- Traffic growth rate per annum: 7.5%
- Design life: 15 years
- Design CBR of subgrade soil: 4%
- Vehicle Damage Factor (VDF): 2.5

Solution:

Step 1: Distribution Factor (DF) Calculation

- For a two-lane single carriageway, the Distribution Factor (DF) is given as 0.75.

Step 2: Cumulative Number of Standard Axles (N) Calculation

These calculations provide the optimal thickness for each pavement layer, based on the given design parameters and IRC:37-2018 guidelines.

Table -1: Pavement thickness by manual method

Total Pavement Thickness	628 mm
Wearing Course	27 mm
Binder Course	63 mm
Granular Base	250 mm
Granular Sub-Base	288 mm

3.1 By Software Calculation

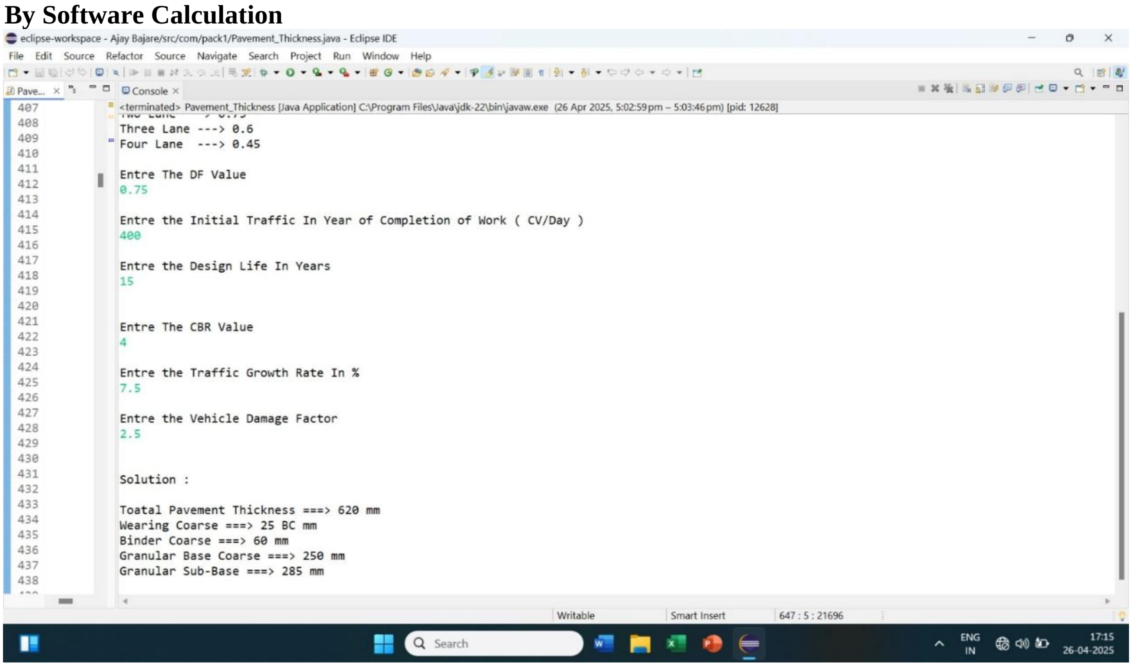

Fig -1: Software calculation

Table -2: Pavement thickness by software

Total Pavement Thickness	620 mm
Wearing Course	25 mm
Binder Course	60 mm
Granular Base	250 mm
Granular Sub-Base	285 mm

4. CONCLUSIONS

The development of a software tool for flexible pavement thickness design represents a major step forward in modernizing and streamlining pavement engineering practices. This project aimed to replace traditional manual methods—based on IRC:37-2001, 2012, and 2018 guidelines—with an automated, user-friendly solution. The software allows students to input essential parameters such as traffic load (MSA), subgrade strength (CBR), and material properties, and quickly obtain accurate pavement thickness recommendations.
By embedding standard design charts and calculations into its algorithm, the tool eliminates the potential for human error due to manual chart reading or interpolation. Its efficiency significantly enhances the speed and reliability of the design process. Furthermore, the software facilitates sensitivity analysis, showing how pavement thickness responds to changes in subgrade strength and traffic volume. This capability underlines the critical need for precise data during the design phase.
Overall, the tool bridges theoretical knowledge with practical application, making pavement design faster, more accurate, and accessible the learners in the field of highway engineering.

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6. REFERENCES

[1]. **IRC:37-2001** provides empirical guidelines for the design of flexible pavements in India.
[2]. **IRC:37-2012** updates pavement design by incorporating traffic growth and material behavior.
[3]. **IRC:37-2018** introduces a mechanistic-empirical approach for more accurate pavement design.

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