International Journal of
AI ELECTRICAL CIVIL AND MECHANICAL ENGINEERING
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0434 www.zesterapublications.com Original Research Paper

ANALYSIS AND DESIGN OF RIGID PAVEMENT USING KENPAVE AND IRC 37

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Abstract

The project “Analysis and Design of Rigid Pavement Using KENPAVE and IRC 58 Methods” focuses on the structural analysis and design of concrete pavement subjected to repeated traffic loading. Rigid pavement mainly consists of a cement concrete slab supported by a base or sub-base layer and subgrade. Proper design is essential to ensure that the pavement can withstand wheel loads, temperature variations, and environmental effects throughout its design life. The study follows the design principles of IRC 58 and uses KENPAVE software to evaluate the structural response of the pavement.

The design process considers important parameters such as design traffic, axle load distribution, concrete strength, flexural strength, elastic modulus, Poisson's ratio, slab thickness, subgrade characteristics, and environmental conditions. IRC 58 is used to determine a suitable pavement configuration and the required slab thickness. KENPAVE is then used to perform analytical evaluation of the pavement structure and determine critical stresses, strains, and deflections under different loading conditions.

The analysis mainly evaluates critical responses such as wheel-load stress, temperature-induced stress, combined stress, and slab deflection. These results are compared with the permissible design criteria to check the structural adequacy of the pavement. Different slab thicknesses and loading conditions can be studied to identify a safe and economical pavement design. The software-based approach also helps reduce repetitive calculations and provides a better understanding of rigid pavement behavior.

Overall, the project demonstrates the application of KENPAVE and IRC 58 methods for the analysis and design of rigid pavements. The study provides a systematic approach for determining suitable concrete slab thickness and evaluating pavement performance under traffic and environmental loading. The final design aims to provide adequate strength, durability, serviceability, and reliability for the expected traffic conditions.

I. Introduction

Rigid pavement is an important type of pavement used for highways, urban roads, airports, and other transportation facilities where high load-carrying capacity and long-term durability are required. Unlike flexible pavement, rigid pavement primarily uses a cement concrete slab to distribute wheel loads over a wider area of the

Received: 24-07-2026 | Accepted: 30-08-2026 | Published: 05-09-2026

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underlying soil. The performance of rigid pavement depends on several factors, including traffic loading, concrete properties, slab thickness, subgrade strength, temperature variations, and environmental conditions. Therefore, proper structural analysis and design are necessary to ensure adequate strength and serviceability throughout the pavement design life.

The design of rigid pavement requires evaluation of stresses and deflections produced by different loading conditions. Wheel loads produce stresses in the concrete slab, while temperature and moisture variations can cause curling and warping stresses. The combined effect of these stresses must be considered while determining the required slab thickness. **IRC 58** provides guidelines for the design of cement concrete pavements in India and considers parameters such as design traffic, axle load spectrum, concrete strength, modulus of elasticity, slab dimensions, foundation characteristics, and environmental conditions.

KENPAVE is a pavement analysis software package that can be used to evaluate stresses, strains, and deflections in pavement structures. It provides an analytical approach for studying the response of pavement layers under different loading conditions. By changing parameters such as slab thickness, material properties, wheel loading, and foundation conditions, the structural response of the rigid pavement can be examined. This helps in understanding the critical loading conditions and evaluating whether the selected pavement structure satisfies the required design criteria.

II. Literature Survey

Several researchers have studied the structural behavior and design of rigid pavements under repeated traffic and environmental loading. Rigid pavement performance is mainly influenced by concrete slab thickness, wheel loading, concrete strength, subgrade support, temperature variations, and joint conditions. Earlier pavement design approaches were largely based on empirical observations and field performance. Later studies introduced analytical and mechanistic methods that calculate stresses and deflections within the pavement system. These approaches provide a better understanding of the behavior of concrete slabs under different loading conditions and help in selecting suitable pavement thickness.

The IRC 58 guidelines provide a systematic procedure for the design of cement concrete pavements in India. The method considers parameters such as design traffic, axle load spectrum, concrete properties, slab dimensions, foundation characteristics, temperature effects, and reliability. The design procedure evaluates critical stresses developed in the concrete slab due to wheel loads and temperature-related effects. Researchers have used IRC 58-based approaches to investigate the influence of traffic loading, slab thickness, concrete strength, and subgrade conditions on pavement performance. These studies have shown that appropriate consideration of traffic and environmental conditions is important for achieving a durable rigid pavement.

Several studies have also used KENPAVE for analyzing pavement structures under different loading conditions. KENPAVE provides an analytical framework for calculating stresses, strains, and deflections within pavement layers. For rigid

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pavement analysis, researchers have investigated the effects of axle loading, slab thickness, concrete material properties, foundation support, and temperature gradients. The software allows different pavement configurations to be evaluated and helps identify critical locations where maximum stress or deflection may occur. Such analysis can reduce repetitive manual calculations and provide a clearer understanding of pavement structural behavior.

Research comparing different rigid pavement design parameters has indicated that slab thickness has a significant influence on the stresses and deflections developed under traffic loading. Increasing slab thickness generally improves load-carrying capacity, while stronger concrete and better foundation support can also improve structural performance. Temperature variations can produce additional stresses because concrete expands and contracts with changes in temperature. Therefore, considering both traffic-induced and temperature-induced stresses is important when evaluating the overall performance of a concrete pavement.

Overall, the existing literature demonstrates the importance of combining IRC 58 design procedures with analytical software such as KENPAVE for rigid pavement evaluation. The present project applies these methods to determine a suitable concrete slab thickness and analyze the structural response of the pavement. Critical stresses, strains, and deflections are evaluated under relevant loading conditions, and the results are compared with the applicable design criteria. This approach provides a systematic basis for developing a safe, durable, and economical rigid pavement structure.

III. System Analysis

System analysis is an important stage in evaluating the structural performance of a rigid pavement under traffic and environmental loading. The project focuses on the analysis and design of a cement concrete pavement using KENPAVE and IRC 58 methods. Important parameters such as design traffic, axle loads, concrete properties, slab thickness, and subgrade characteristics are considered. The concrete slab is modeled with suitable material properties and foundation support conditions. Wheel loads are applied at critical positions to evaluate the response of the pavement slab. Temperature-related effects are also considered because temperature variations can produce additional stresses in concrete pavement. KENPAVE is used to calculate important parameters such as stresses, strains, and deflections. The results are evaluated for different loading conditions to identify the critical pavement response. IRC 58 design provisions are used to determine suitable slab thickness and assess structural adequacy. Critical stress conditions are compared with the permissible design criteria. The analysis helps identify whether the proposed pavement can withstand the expected traffic and environmental effects. Different pavement parameters can also be modified to study their influence on structural performance. Overall, the system analysis provides a systematic approach for developing a safe and durable rigid pavement design.

Existing System

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The conventional rigid pavement design system mainly depends on manual calculations, design charts, empirical procedures, and repeated analytical calculations. Engineers need to collect traffic data and determine the design axle load before evaluating the pavement structure. Concrete properties, slab thickness, foundation support, and temperature conditions must be considered separately during the design process. Calculating wheel-load stresses and temperature stresses manually can require considerable time and effort. The combined effect of different stresses may also be difficult to evaluate using basic calculation procedures. When pavement thickness or material properties are changed, many calculations need to be performed again. Traditional methods provide limited graphical representation of stress and deflection distribution within the pavement. Comparing different pavement configurations manually can therefore become complicated. There is also a possibility of calculation and data-entry errors when several loading conditions are involved. Preparing detailed design calculations and reports requires additional effort. Conventional approaches may not efficiently handle complex pavement analysis conditions. Therefore, a computer-based analytical approach is useful for improving the efficiency of rigid pavement design. KENPAVE can provide a systematic platform for analyzing stresses, strains, and deflections.

Disadvantages of Existing System

- Requires extensive manual calculations.
- Time-consuming for complex rigid pavement analysis.
- Higher possibility of calculation and data-entry errors.
- Difficult to evaluate combined traffic and temperature stresses manually.
- Repeated calculations are required for different slab thicknesses.
- Difficult to compare multiple pavement configurations efficiently.
- Limited visualization of stress and deflection distribution.
- Difficult to identify critical loading conditions quickly.
- Limited automation in pavement performance evaluation.

Proposed System

The proposed system focuses on the analysis and design of rigid pavement using KENPAVE and IRC 58 methods. The design begins with collecting traffic, material, foundation, and environmental parameters required for pavement evaluation. Design traffic and critical axle loading conditions are determined based on the expected highway traffic. Concrete properties such as flexural strength, elastic modulus, and Poisson's ratio are defined for the pavement slab. Subgrade and foundation characteristics are considered to represent the support provided below the concrete slab. A suitable initial slab thickness is selected according to the IRC 58 design approach. The pavement structure is then analyzed using KENPAVE under relevant wheel-loading conditions. The software calculates critical stresses, strains, and deflections developed within the pavement system. Temperature-related effects can also be considered to evaluate additional stresses in the concrete slab. The calculated responses are compared with the applicable permissible design criteria. If the selected slab thickness does not satisfy the requirements, the thickness or other design parameters can be modified. Different design alternatives can therefore be evaluated to obtain a suitable pavement configuration. The proposed system reduces repetitive

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manual calculations and improves the efficiency of structural pavement analysis. Overall, the system provides a systematic approach for designing a safe, durable, and economical rigid pavement.

Advantages of Proposed System

- Provides computer-aided rigid pavement analysis.
- Reduces manual calculation effort.
- Follows the IRC 58 design approach.
- Uses KENPAVE for analytical pavement evaluation.
- Calculates critical stresses, strains, and deflections.
- Helps evaluate wheel-load effects.
- Allows consideration of temperature-related stresses.
- Makes comparison of different slab thicknesses easier.
- Provides a systematic basis for design reporting.

IV. Methodology

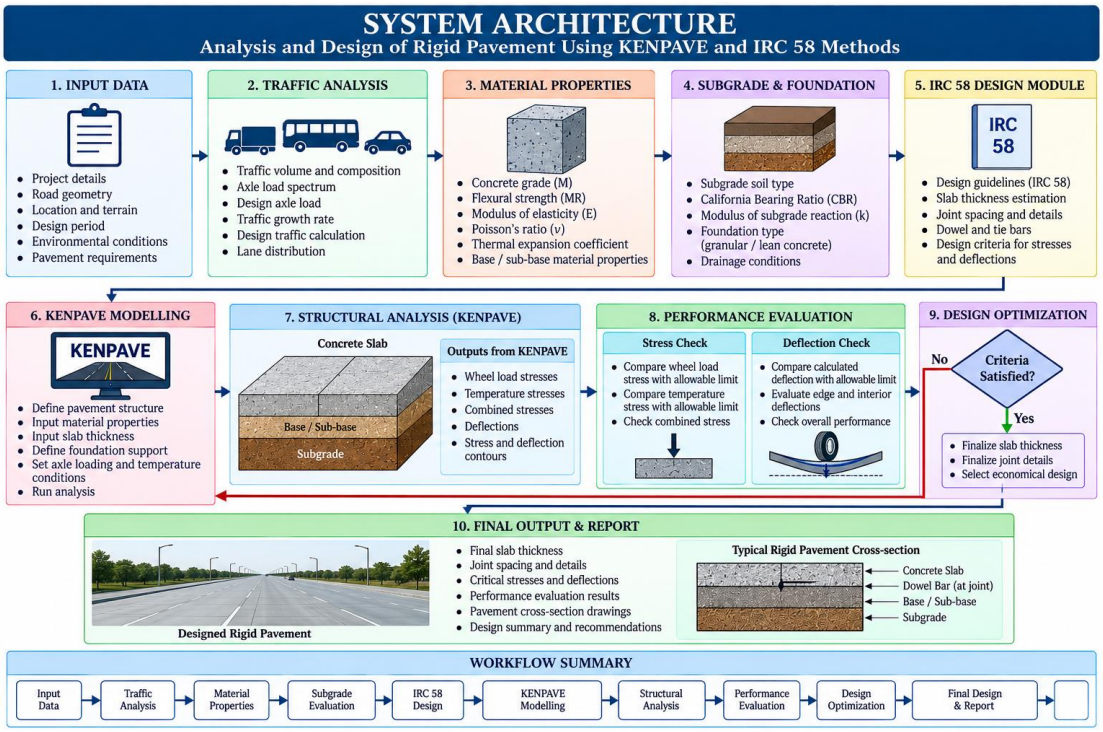
The methodology begins with collecting the required traffic, pavement, material, and environmental data for the proposed rigid pavement. The design traffic and critical axle load information are determined based on the expected number and type of vehicles. Concrete properties such as flexural strength, modulus of elasticity, and Poisson's ratio are selected according to the design requirements. The subgrade and foundation support characteristics are established for the pavement structure. An initial concrete slab thickness is selected using the relevant provisions of IRC 58. The pavement structure and material properties are then defined in KENPAVE for analytical evaluation. Wheel loads are applied at critical locations to determine the stresses and deflections in the concrete slab. Temperature conditions are considered to evaluate temperature-induced stresses where applicable. KENPAVE calculates the critical structural responses for the specified loading conditions. The obtained stresses and deflections are compared with the permissible design criteria. If the calculated values exceed the required limits, the slab thickness or pavement parameters are modified. The revised pavement structure is re-analyzed until the required performance criteria are satisfied. Finally, the selected pavement design and analysis results are documented for evaluating the structural adequacy and performance of the rigid pavement.

System Architecture

The system architecture represents the complete workflow used for analyzing and designing rigid pavement using KENPAVE and IRC 58 methods. The process begins with Project Input Data, including road characteristics, design period, traffic information, and pavement requirements. The Traffic Analysis Module evaluates axle loads, traffic volume, and design traffic required for pavement analysis. The Material Properties Module defines concrete strength, elastic modulus, Poisson's ratio, and other pavement material parameters. The Subgrade and Foundation Module specifies the supporting soil and foundation characteristics. The IRC 58 Design Module uses the required design parameters to determine the initial concrete slab thickness. The pavement structure is then modeled in the KENPAVE Analysis Module with

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appropriate layer and loading conditions. The Load Analysis Module evaluates wheel-load effects and relevant temperature loading conditions. KENPAVE calculates critical stress, strain, and deflection responses in the pavement system. The Performance Evaluation Module compares the calculated responses with the applicable design criteria. The Design Optimization Module modifies slab thickness or other parameters when the design requirements are not satisfied. Finally, the Results and Reporting Module generates the final slab thickness, stress and deflection results, performance checks, and design summary. Overall, the architecture follows the workflow **Input Data → Traffic Analysis → Material Properties → Subgrade Evaluation → IRC 58 Design → KENPAVE Modeling → Load Analysis → Stress & Deflection Evaluation → Performance Check → Design Optimization → Final Design & Report**.



V. Result and Output

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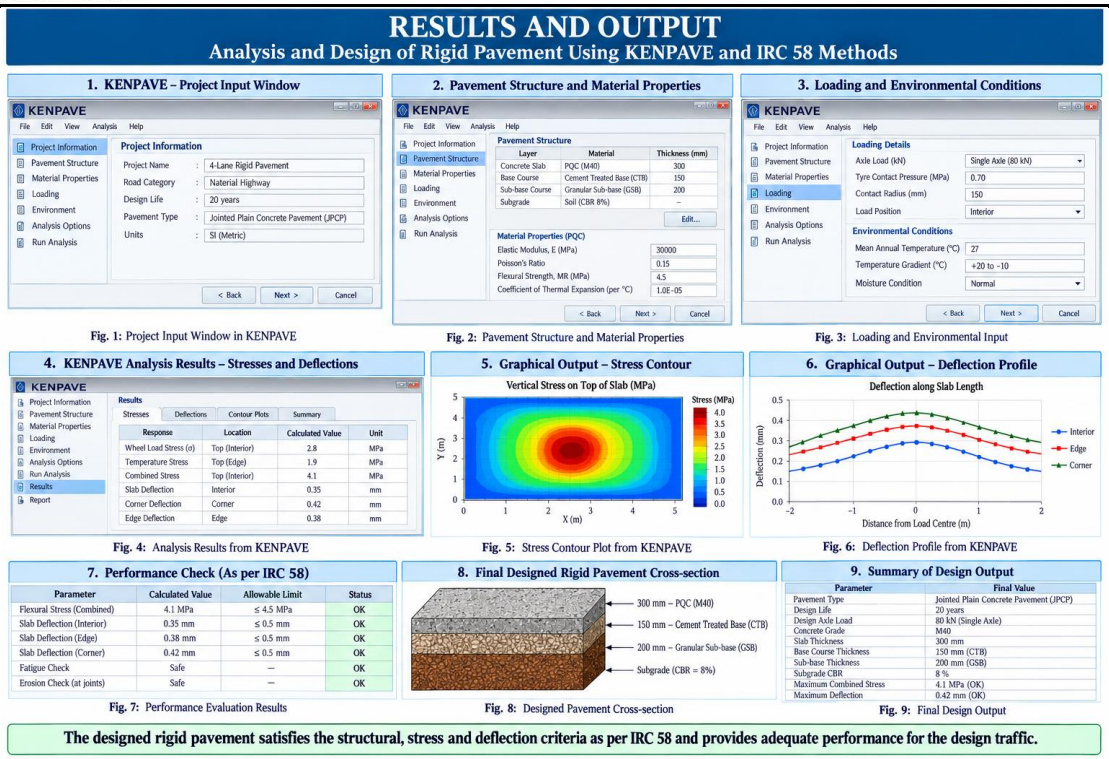


Fig. 1: Project Input Window in KENPAVE

Fig. 2: Pavement Structure and Material Properties

Fig. 3: Loading and Environmental Input

Fig. 4: Analysis Results from KENPAVE

Fig. 5: Stress Contour Plot from KENPAVE

Fig. 6: Deflection Profile from KENPAVE

Fig. 7: Performance Evaluation Results

Fig. 8: Designed Pavement Cross-section

Fig. 9: Final Design Output

VI. Conclusion

The project successfully demonstrated the analysis and design of rigid pavement using KENPAVE and IRC 58 methods. The required traffic loading, concrete properties, slab thickness, subgrade characteristics, and environmental conditions were considered for the pavement design. A suitable rigid pavement structure was developed based on the design requirements specified by IRC 58. KENPAVE was used to evaluate the stresses, strains, and deflections developed in the pavement under different loading conditions. The analysis helped identify critical wheel-load and temperature-related stresses in the concrete slab. The calculated structural responses were compared with the applicable permissible design criteria to assess pavement performance. The study showed the importance of selecting an appropriate slab thickness to safely withstand repeated traffic loading. The use of KENPAVE reduced repetitive manual calculations and provided a convenient method for evaluating pavement behavior. The combination of IRC 58 guidelines and KENPAVE analysis provided a systematic approach for checking the structural adequacy of the pavement. Overall, the designed rigid pavement provides adequate strength, durability, and serviceability for the considered design conditions. The methodology can also be extended by studying different traffic levels, slab thicknesses, concrete properties, and foundation conditions for optimized rigid pavement design.

References

[1] Kumar, R. D., Prudhviraj, G., Vijay, K., Kumar, P. S., & Plugmann, P. (2024). Exploring COVID-19 through intensive investigation with supervised machine learning algorithm. In Handbook of Artificial Intelligence and Wearables (pp. 145-158). CRC Press.

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ISSN: 3070-0434 www.zesterapublications.com Original Research Paper

[2] Swathi, B., Vijay, K., Sushanth Babu, M., & Dinesh Kumar, R. (2024, November). Machine Learning Techniques in Cloud Based Intrusion Detection. In The International Conference on Artificial Intelligence and Smart Environment (pp. 557-564). Cham: Springer Nature Switzerland.

[3] Sv satyakrishna, shirisha rangu ,bhargavi nalacheruve.(2024) Prospective investigation on colorectal cancer with SMOTE on machine learning Algorithm

[4] Dr.G.Vishnu Murthy, BhargaviNalacheruve 1Professor, Department of computer Science & engineering, Anurag University, TS, India. 2Student, Department of computer Science & engineering, Anurag University, TS, India.

[5] V. N. S. Manaswini, K. K, C. Nigam, S. S. Ali, R. Niranjana, and Suman, "Real-Time Object Detection in Drone Surveillance Using YOLOv5," in Proc. 2025 3rd Int. Conf. IoT, Communication and Automation Technology (ICICAT), Gorakhpur, India, 2025, pp. 1–6, doi: 10.1109/ICICAT68430.2025.11414670.

[6] B. Soundarya, V. N. S. Manaswini, M. Ayyakrishnan, R. D. Kumar, "Contextual Analysis of Big Data Analytics in Intelligent Transportation Frameworks," in Intersection of Artificial Intelligence, Data Science, and Cutting-Edge Technologies: From Concepts to Applications in Smart Environment, Lecture Notes in Networks and Systems, vol. 1353, Cham: Springer, 2025, doi: 10.1007/978-3-031-88304-0_79.

[7] R. D. Kumar, V. N. S.Manaswini, "Applications of blockchain in smart cities: detecting fake documents from land records using blockchain technology," in Blockchain for Smart Cities, Elsevier, 2021, pp. 105–117, doi: 10.1016/B978-0-12-824446-3.00017-X.

[8] Tejavath Veeramma, Badarla Anil, Guguloth Ravinder, "An advanced movie recommender using collaborative filtering and sentiment analysis," International Research Journal of Modernization in Engineering Technology and Science, vol. 7, no. 7, July 2025, doi: 10.56726/IRJMETS81618.

[9] Ravi Kumar Banoth, Ramana Murthy B V, "Automatic crop recommendation system using LightGBM and decision tree machine learning models," Journal of Machine and Computing, vol. 5, no. 1, pp. 343, Jan. 2025, doi: 10.53759/7669/jmc202505026.

[10] Ravi Kumar Banoth, Dr. B.V. Ramana Murthy, "Smart agriculture through IoT and machine learning for analyzing carbon footprints," in Proc. Int. Conf. Computer Science and Communication Engineering (ICCSCE), Apr. 2025.

[11] Ravi Kumar Banoth, B. V. Ramana Murthy, "Soil image classification using transfer learning approach: MobileNetV2 with CNN," SN Computer Science, vol. 5, art. no. 199, 2024, doi: 10.1007/s42979-023-02500-x.