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"STUDY OF FLEXIBLE PAVEMENT FOR TWO-LANE ROAD (THANAGAZI BYPASS, ALWAR, RAJASTHAN)"

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ABSTRACT

Road transportation plays a vital role in the economic development of a country. Proper design of pavement is essential to ensure durability, safety, and smooth transportation of vehicles. Flexible pavements are widely used due to their adaptability and cost-effectiveness compared to rigid pavements. This study focuses on the design and analysis of flexible pavement for the two-lane highway stretch of Thanagazi Bypass in Alwar district, Rajasthan. The project road is a part of NH-248A with a total length of approximately 25.66 km. Soil samples collected from the project location were tested in the laboratory to determine engineering properties such as liquid limit, plastic limit, sieve analysis, Proctor compaction test, and California Bearing Ratio (CBR) test. The pavement thickness was designed based on the CBR method and Group Index method as recommended by IRC guidelines. The results show that the soil has moderate strength characteristics with CBR values ranging from 12% to 14% under unsoaked conditions. Based on the design analysis, suitable pavement layers consisting of subgrade, granular subbase (GSB), wet mix macadam (WMM), and bituminous layers were recommended. The study concludes that proper pavement design based on soil characteristics and traffic demand ensures long service life and improved road performance.

Key Words: *Flexible Pavement, Pavement Design, CBR Test, Soil Analysis, Highway Engineering, IRC Guidelines*

I. INTRODUCTION

Highway infrastructure is an important component of economic growth and development. Efficient transportation systems require well-designed pavements that can sustain heavy traffic loads and environmental conditions. Pavements are broadly classified into flexible pavements and rigid pavements depending on their structural behavior.

Flexible pavements distribute wheel loads through layered systems consisting of surface course, base course, sub-base course, and subgrade. These pavements are designed to transmit traffic loads to the lower layers in a gradual manner. The flexibility of these pavements allows them to adapt to minor settlements without cracking.

The present study focuses on the design and analysis of a flexible pavement for a two-lane highway located at Thanagazi Bypass in Alwar district, Rajasthan. The project involves laboratory investigation of soil properties and determination of pavement thickness based on standard IRC design procedures.

II. LITERATURE REVIEW

- Several researchers have investigated pavement design methods and performance characteristics of flexible pavements.
- Saurabh Jain et al. studied different design methods for flexible and rigid pavements and conducted cost analysis for various pavement structures.

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- D.S.V. Prasad and G.V.R. Prasada Raju investigated the performance of flexible pavements constructed over expansive soils using reinforced sub-base materials. Their results indicated improved load carrying capacity when reinforcement materials were used.
- Other studies highlighted the importance of soil testing, traffic analysis, and appropriate material selection for pavement design. Flexible pavements offer advantages such as ease of maintenance, lower initial cost, and adaptability to stage construction.

III. METHEDOLOGY

The study involved field investigations and laboratory testing to determine the engineering properties of soil and pavement materials.

The methodology adopted includes:

1. Collection of soil samples from project site
2. Laboratory testing of soil properties
3. Traffic survey and classification
4. Pavement thickness design using IRC guidelines
5. Evaluation of results and recommendations

Traffic surveys were conducted to understand the composition of motorized and non-motorized traffic and estimate design traffic for pavement design.

LABORATORY TESTS

Various laboratory tests were performed to determine soil characteristics.

- **Liquid Limit Test**
  Liquid limit represents the moisture content at which soil changes from plastic to liquid state. The liquid limit values obtained for soil samples were:
  - Sample 1 = 24%
  - Sample 2 = 22.5%
  - Sample 3 = 20%

  These values indicate medium plasticity soil suitable for subgrade construction.
- **Plastic Limit Test:**
  Plastic limit is the moisture content at which soil begins to crumble when rolled into threads of 3 mm diameter.
  Plastic limit values obtained:
  - Sample 1 = 14.28%
  - Sample 2 = 11.11%
  - Sample 3 = 10.16%

  Plasticity index values ranged from **9–11%**, indicating moderate plastic soil.
- **Sieve Analysis**
  Sieve analysis was conducted to determine particle size distribution of soil
  Results showed:
  Sample 1
  D10 = 0.18
  - D30 = 0.4
  - D60 = 0.65
  - Uniformity coefficient = 3.61

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Sample 2

- Uniformity coefficient = 11.86

These results indicate well-graded soil suitable for pavement subgrade.

- **Proctor Compaction Test**
  Proctor compaction test determines optimum moisture content and maximum dry density of soil.
  Results obtained:
  Sample 1
  - Optimum moisture content = 10.63%
  - Maximum dry density = 1.678 g/cc

Sample 2

- Optimum moisture content = 8.1%
- Maximum dry density = 1.91 g/cc

- **CBR Test**
  CBR test evaluates the strength of subgrade soil.
  Results:
  Sample 1
  CBR (2.5 mm penetration) = **14.36%**
  Sample 2
  CBR = **12.42%**
  Soaked condition CBR values ranged between **4–5%**.

These values indicate moderate subgrade strength suitable for flexible pavement design.

IV. RESULT ANALYSIS & DISCUSSION

Pavement thickness was determined using:

- Group Index Method
- CBR Method

Based on IRC design charts and laboratory results, the recommended pavement layers are:

Layer	Thickness
Subgrade	500 mm
Granular Sub Base (GSB)	200 mm
Wet Mix Macadam (WMM)	210 mm
Dense Bituminous Macadam (DBM)	50 mm
Bituminous Concrete (BC)	40 mm

Total pavement thickness ≈ **1080 mm**.

The laboratory test results indicate that the soil possesses moderate plasticity and acceptable strength characteristics for highway construction.
The CBR values obtained suggest that the soil can support flexible pavement layers with appropriate thickness design.
The recommended pavement structure ensures adequate load distribution and durability under medium traffic conditions.
The analysis also highlights the importance of proper compaction and moisture control to achieve optimum pavement performance.

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V. CONCLUSION

- This study presented the design and analysis of flexible pavement for a two-lane highway located at Thanagazi Bypass in Alwar district, Rajasthan. Laboratory investigations were conducted to evaluate soil properties and determine pavement thickness.
- The results indicate that the soil possesses moderate engineering properties with CBR values between 12% and 14%. Based on IRC guidelines, a flexible pavement structure consisting of subgrade, granular subbase, wet mix macadam, and bituminous layers was recommended.
- Proper pavement design based on soil characteristics and traffic demand ensures long-term performance and improved transportation efficiency. The study demonstrates the importance of laboratory testing and design methodology in achieving economical and durable pavement construction.

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