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# LIFE CYCLE COST ANALYSIS OF ROAD BY USING ANN METHOD

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***Abstract- Road construction requires huge investment not only in the construction of new infrastructure but also in the repair and maintenance of old ones. In the case of developing countries like India, there is a shortage of funds required for the construction of new infrastructure projects and more important for their maintenance and repair. Today's focus is on long-lasting pavement construction. Most of our roads show early signs of accidents due to bituminous pavements, increased load, traffic intensity, high tire pressure, etc. Concrete pavements can be taken as an alternative to traditional bituminous pavements. . One of the alternative rehabilitation solutions for bituminous overlaps is the use of white topping overlays on existing bituminous pavements. This study attempts to estimate the life cycle cost of concrete and bituminous pavements using ANNs and suggests a beneficial alternative between them.***

## I. INTRODUCTION

In most countries with developed road networks, new road construction usually accounts for more than 50% of the road budget. The rest of the national highway budget will be spent on maintenance and rehabilitation of existing roads. The long-term pavement (LLP) project will be approved if future maintenance, rehabilitation and road user delay costs are financially justified. There has historically been a difference of opinion as to whether hot mix asphalt (flexible) pavements are more economical or less economical over time than Portland cement concrete (hardened) pavements. Experienced state road agencies and highway engineers also disagree on the matter. Ethiopia is undertaking large-scale development programs to address the country's poverty problems and bring the country to the level of middle-income countries by 2025.

This research provides information about the LCCA's vision pavement and the LCCA is an economic method for comparing alternatives that can meet the need to determine the minimum cost option. This study attempts to evaluate the life cycle cost analysis of concrete and bituminous pavements and suggests a profitable alternative between them.

### A. Objectives

The main objectives of the project are:

1. To study the concept of life cycle cost benefit of rigid pavement and bituminous pavement.
2. To study cost benefit analysis using LCCA and ANN.
3. To prepare comparative analysis of rigid pavement and bituminous pavement using MATLAB or any other equivalent tools
4. Result analysis of comparative analysis of rigid pavement and bituminous pavement which include cost benefit analysis which will be subpart of LCCA

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## II. LCCA PROCEDURE

The LCCA structured approach can be explained in the following steps:

1) Define project options..
2) Decide on the approach: Probabilistic vs. Deterministic.
3) Choose general economic parameters: Discount Rate, Analysis Period.
4) Establish expenditure stream for each alternative:
   a) Design rehabilitation strategies and their timings.
   b) Estimate differential agency costs.
   c) Estimate differential user costs.
   d) Estimate differential societal costs.
5) Compute Net Present Value for each alternative.
6) Compare and interpret results/ Sensitivity Analysis.
7) Re-evaluate design strategies if needed.

### A. Procedure of Ann For Construction

In this project we implemented an artificial neural network using Matlab to analyze structural delays.

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Matlab is a software that can detect time lag using a neural network toolbox. The NN Toolbox contains several network algorithms. Using the NN algorithm we provide time input and get optimized output. The following is a step-by-step approach to evaluating time delays

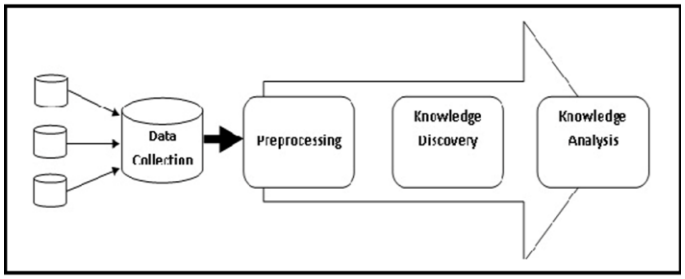


Fig 1 Basic stages of MATLAB

## III. ANALYTICAL STUDY

### A. LCCA Using ANN

In this chapter the subject of study of this article is discussed in detail in this chapter. This chapter also describes what work was done during the project. The details of the project are explained step by step in the chapter. This chapter describes the methodology used to create Artificial Neural Network (ANN) modeling in Matlab software. This chapter contains the results and reports on the various tools used to construct mathematical models, which are the illusion matrix and graphical performance characteristics of the receiver. The various problems encountered in this process are also briefly mentioned in the discussion.

### B. LCCA of Rigid Pavement over Flexible PavementStudy Area 1

Table 1 LCCA of Rigid Pavement over Flexible Pavement

| **Life Cycle Cost Comparison for Flexible Pavement vs Rigid Pavement** | | | | |
|---|---|---|---|---|
| | **Assumptions** | | | |
| | Rate of Inflation | | 5% | |
| | Discount Rate | | 12% | |
| | **Year** | **Cum. (Initial cost + Maintenance cost) Rigid Pavement** | **Cum. (Initial cost + Maintenance cost) Flexible Pavement** | **Remarks** |
| | 2017 | 22.35 | 20.31 | Initial Constructio |
| | 2018 | 85.22 | 77.42 | |
| 1.00 | 2019 | **203.11** | **184.50** | n cost is high for Rigid Pavement by 10.08% |
| 2.00 | 2020 | 203.29 | 184.92 | |
| 3.00 | 2021 | 203.46 | 185.31 | |
| 4.00 | 2022 | 203.63 | 185.68 | |
| 5.00 | 2023 | 203.78 | 186.03 | |
| 6.00 | 2024 | 203.92 | 195.67 | |
| 7.00 | 2025 | 204.05 | 195.98 | |
| 8.00 | 2026 | 204.18 | 196.26 | |
| 9.00 | 2027 | 204.30 | 196.53 | |
| 10.00 | 2028 | 204.41 | 196.77 | |
| 11.00 | 2029 | 204.51 | 203.76 | |
| 12.00 | 2030 | 204.61 | 203.98 | |
| 13.00 | 2031 | 204.70 | 204.19 | |
| 14.00 | 2032 | 204.78 | 204.38 | |
| 15.00 | 2033 | 204.86 | 204.56 | |
| 16.00 | 2034 | 204.93 | 220.80 | Break-evenpoint |
| 17.00 | 2035 | 205.00 | 220.96 | |
| 18.00 | 2036 | 205.07 | 221.11 | |
| 19.00 | 2037 | 205.13 | 221.25 | |
| 20.00 | 2038 | 205.19 | 221.38 | |
| 21.00 | 2039 | 205.24 | 225.77 | |
| 22.00 | 2040 | 205.29 | 225.88 | |
| 23.00 | 2041 | 205.34 | 225.99 | |
| 24.00 | 2042 | 205.39 | 226.09 | |
| 25.00 | 2043 | 205.43 | 226.19 | |
| 26.00 | 2044 | 205.47 | 229.36 | |
| 27.00 | 2045 | 205.50 | 229.45 | |
| 28.00 | 2046 | 205.54 | 229.52 | Life cycle cost for rigid pavement is cheaper by -10.39% |
| 29.00 | 2047 | 205.57 | 229.60 | |
| 30.00 | 2048 | 205.79 | 229.67 | |

**i) Rate of Inflation: -** Inflation rate is the increase or decrease of prices over a period of time, usually for a month or a year. Percentage indicates how much prices have risen during this period.

**ii) Discount Rate: -** It's the rate of return that the investors expect or the cost of borrowing money.

### C. Experimental Results and DiscussionFor Study area 1

- **ANN toolbox consist of several implemented NN algorithm**

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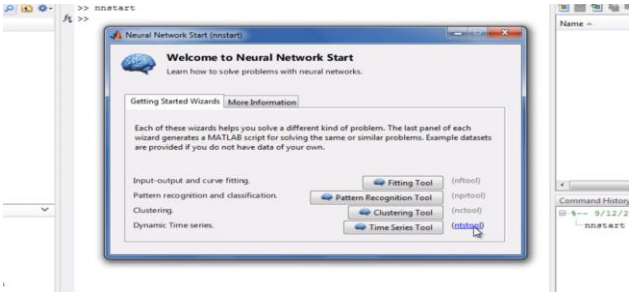
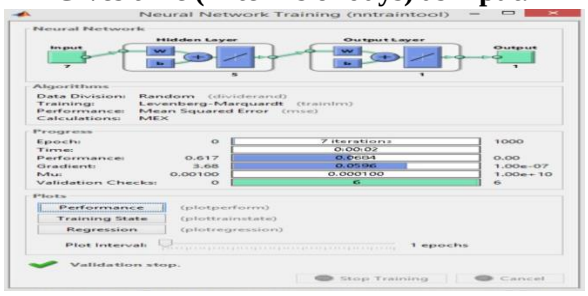
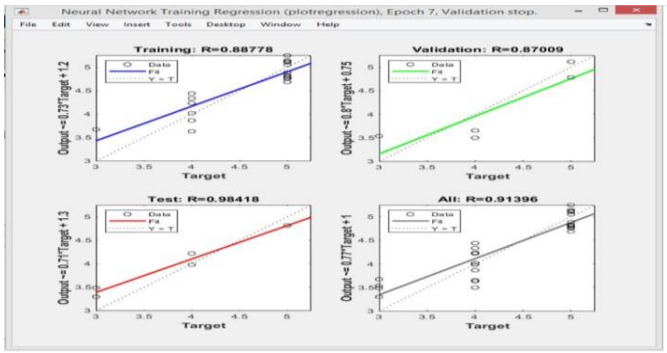


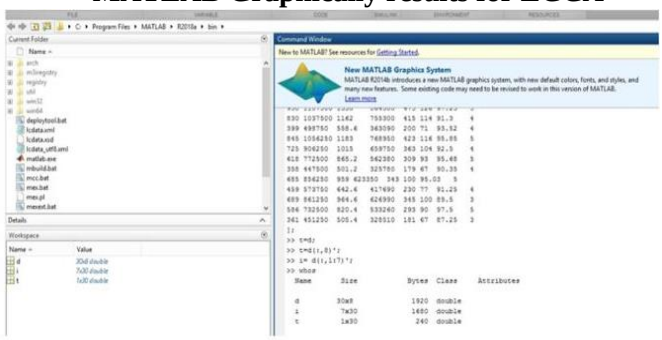

- **Gives time (in terms of days) as input.**




- **LCCA Results in MATLAB**




- **MATLAB Graphically results for LCCA**



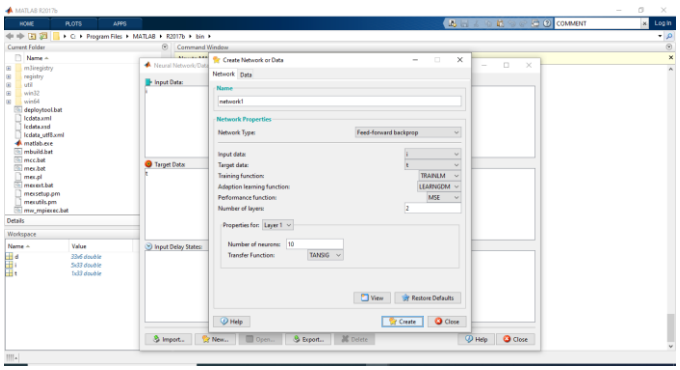

**C. LCCA of Rigid Pavement over Flexible Pavement Study Area 2**

Table 2 LCCA of Rigid Pavement over Flexible Pavement

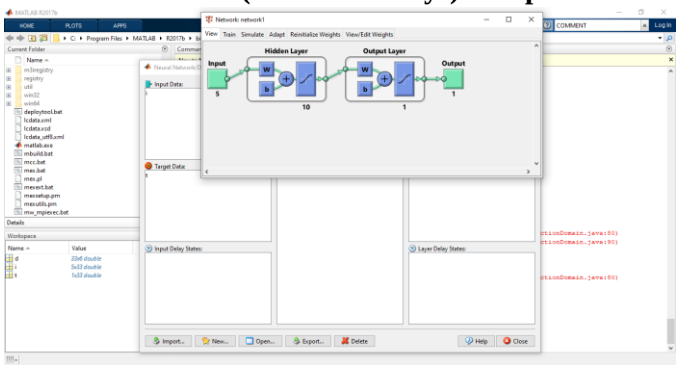
| Life Cycle Cost Comparison for Flexible Pavement vs Rigid Pavement | | | | | |
|---|---|---|---|---|---|
| | | **Assumptions** | | | |
| | | Rate of Inflation | 5% | | |
| | | Discount Rate | 12% | | |
| | Year | **Cum. (Initial cost + Maintenance cost) Rigid Pavement** | **Cum. (Initial cost + Maintenance cost) Flexible Pavement** | **Remarks** | |
| | 2020 | 54.98 | 44.58 | Initial Construction cost is high for Rigid Pavement by 23.33% | |
| | 2021 | 209.60 | 169.96 | | |
| 1.00 | 2022 | **499.53** | **405.04** | | 23.33% |
| 2.00 | 2023 | 499.98 | 405.96 | | 23.16% |
| 3.00 | 2024 | 500.40 | 406.82 | | 23.00% |
| 4.00 | 2025 | 500.80 | 407.63 | | 22.86% |
| 5.00 | 2026 | 501.18 | 408.38 | | 22.72% |
| 6.00 | 2027 | 501.53 | 435.34 | | 15.20% |
| 7.00 | 2028 | 501.85 | 436.01 | | 15.10% |
| 8.00 | 2029 | 502.16 | 436.63 | | 15.01% |
| 9.00 | 2030 | 502.45 | 437.21 | | 14.92% |
| 10.00 | 2031 | 502.72 | 437.76 | | 14.84% |
| 11.00 | 2032 | 502.97 | 457.28 | | 9.99% |
| 12.00 | 2033 | 503.21 | 457.76 | | 9.93% |
| 13.00 | 2034 | 503.43 | 458.22 | | 9.87% |
| 14.00 | 2035 | 503.64 | 458.64 | | 9.81% |
| 15.00 | 2036 | 503.84 | 459.04 | | 9.76% |
| 16.00 | 2037 | 504.02 | 490.67 | | 2.72% |
| 17.00 | 2038 | 504.19 | 491.01 | | 2.68% |
| 18.00 | 2039 | 504.36 | 491.34 | | 2.65% |
| 19.00 | 2040 | 504.51 | 491.65 | | 2.62% |
| 20.00 | 2041 | 504.65 | 491.94 | | 2.58% |
| 21.00 | 2042 | 504.78 | 502.17 | | 0.52% |
| 22.00 | 2043 | 504.91 | 502.43 | | 0.49% |
| 23.00 | 2044 | 505.02 | 502.66 | | 0.47% |
| 24.00 | 2045 | 505.13 | 502.88 | | 0.45% |
| 25.00 | 2046 | 505.23 | 503.09 | | 0.43% |
| 26.00 | 2047 | 505.33 | 510.51 | Break-even point | -1.01% |
| 27.00 | 2048 | 505.42 | 510.69 | | -1.03% |
| 28.00 | 2049 | 505.51 | 510.86 | | -1.05% |
| 29.00 | 2050 | 505.59 | 511.02 | | -1.06% |
| 30.00 | 2051 | 506.13 | 511.17 | Life cycle cost for rigid pavement is cheaper by - .99% | -0.99% |

D. **Experimental Results and Discussion For Study area 2**

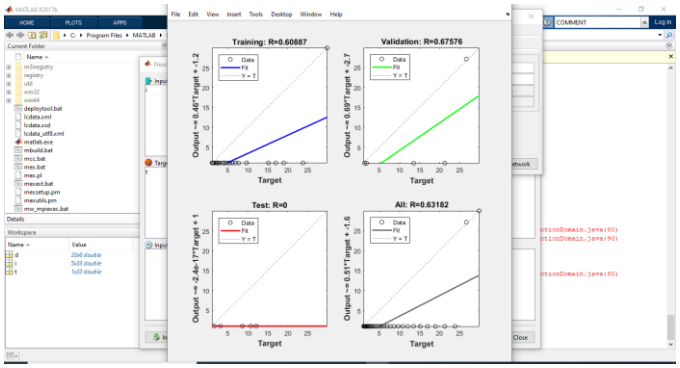
- **Create network Data**



- **Gives time (in terms of days) as input.**



- **LCCA Results in MATLAB**



## VI. CONCLUSION

Based on the results of the research study, it was found that a stable pavement has a longer service life (more than twice) compared to a comfortable pavement. For a (1 km) road length, the cost of a rough pavement life cycle is less than 7.9 million ETB (existing bank) compared to a comfortable pavement over an analytical period of forty (40) years. The cost of general and periodic maintenance over a period of 40 years is 1.1 times higher than the initial construction cost of one kilometer expansion for flexible pavements and requires 7.3 million for maintenance and rehabilitation over rough pavements. The initial construction cost is 10.08% higher for hardened pavement.

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