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Research Study on Cost and Benefit Analysis of Rigid and Flexible Pavement

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ABSTRACT: In many countries with developed road networks, new road construction typically accounts of more or less 50% of the road budget. While the remainder of national road budgets is spent on maintenance and rehabilitation of existing roads. Long-life Pavements (LLP) project is approved if the costs of future maintenance, rehabilitation and the resulting road user delay costs are economically justified. There has been historically difference of opinion as to whether Hot Mix Asphalt (flexible) pavements are more economical or less economical over time, than Portland Cement Concrete (rigid) pavements. Even experienced state highway agencies and highway engineers disagree on the subject. In this study will evaluate initial construction cost for one kilometer of both flexible and rigid pavement and evaluate Life cycle cost analysis (LCCA) for both pavements by present worth method for 30 year analysis period.

KEYWORD: Cost, LCCA, LLP, Rigid Pavement, flexible Pavement

I. INTRODUCTION

In many countries with developed road networks, new road construction typically accounts of more or less 50% of the road budget. While the remainder of national road budgets is spent on maintenance and rehabilitation of existing roads. Long-life Pavements (LLP) project is approved if the costs of future maintenance, rehabilitation and the resulting road user delay costs are economically justified. Road building needs huge investments not only for construction of new infrastructure but also for the repair and maintenance of the old ones. In case of developing countries, like India, there is a shortage of funds required for new infrastructure projects both for construction and more significantly for their maintenance and repairs. Road building needs huge investments not only for construction of new infrastructure but also for the repair and maintenance of the old ones. In case of developing countries, like India, there is a shortage of funds required for new infrastructure projects both for construction and more significantly for their maintenance and repairs

A. Flexible pavement

Flexible Pavements are constructed from bituminous or unbound material and the stress is transmitted to the sub-grade through the lateral distribution of the applied load with depth. Flexible pavement is composed of a bituminous material surface course and underlying base and sub base courses. The bituminous material is more often asphalt whose viscous nature allows significant plastic deformation. Most asphalt surfaces are built on a gravel base, although some 'full depth' asphalt surfaces are built directly on the subgrade.

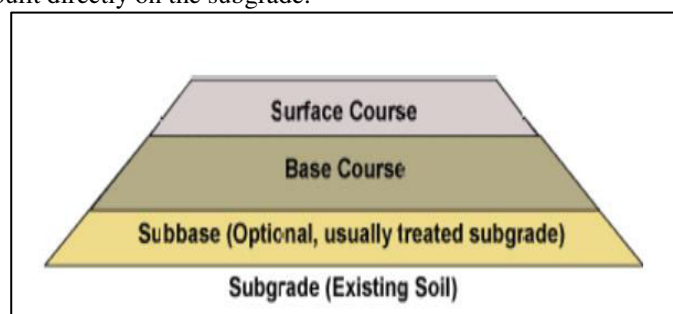


Fig 1 Flexible pavement

B. Rigid Pavements

A rigid pavement is constructed from cement concrete or reinforced concrete slabs. Grouted concrete roads are in the category of semi-rigid pavements. The design of rigid pavement is based on providing a structural cement concrete slab of sufficient strength to resist the loads from traffic. The rigid pavement has rigidity and high modulus of elasticity to distribute the load over a relatively wide area of soil. Rigid pavements are composed of a cement concrete surface course and concealed base and sub base courses.

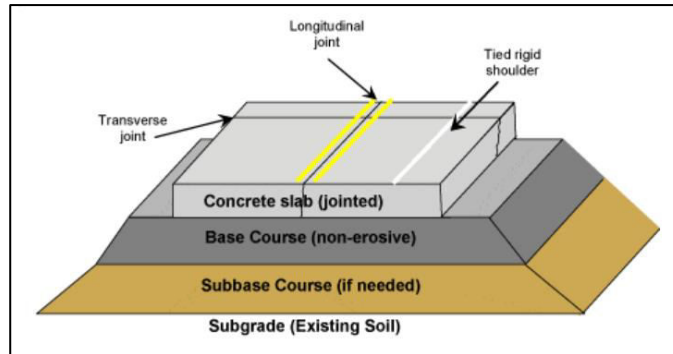


Fig 2 Rigid Pavements

Table 11 Difference between Flexible Pavements and Rigid Pavements

| SR. No. | Flexible Pavement | Rigid Pavement |
|---------|--|--|
| 1 | It consists of a series of layers with the highest quality materials at or near the surface of pavement. | It consists of one layer Portland cement concrete slab or relatively high flexural strength. |
| 2 | It reflects the deformations of subgrade and subsequent layers on the surface. | It is able to bridge over localized failures and area of inadequate support. |
| 3 | Its stability depends upon the aggregate interlock, particle friction and cohesion. | Its structural strength is provided by the pavement slab itself by its beam action. |
| 4 | Pavement design is greatly influenced by the subgrade strength. | Flexural strength of concrete is a major factor for design. |
| 5 | It functions by a way of load distribution through the component layers | It distributes load over a wide area of subgrade because of its rigidity and high modulus of elasticity. |
| 6 | Temperature variations due to change in atmospheric conditions do not produce stresses in flexible pavements. | Temperature changes induce heavy stresses in rigid pavements. |
| 7 | Flexible pavements have self-healing properties due to heavier wheel loads are recoverable due to some extent. | Any excessive deformations occurring due to heavier wheel loads are not recoverable, i.e. settlements are permanent. |

II. CONCEPT OF LIFE CYCLE COST

This chapter gives information about LCCA Rigid pavement and LCCA is an economic method to compare alternatives that satisfy a need in order to determine the lowest cost alternative. In this study an attempt is made to evaluate lifecycle cost analysis of concrete and bituminous pavements and suggest a beneficial alternative amongst them

Typically, LCCA involves the following basic steps:

- **Make initial strategy and analysis decisions.** Certain baseline decisions, estimates and assumptions are needed in order to establish the parameters under which a LCCA can be carried out.
- **Estimate costs.** Costs associated with the owning agency and users are calculated for each alternative.
- **Compare alternatives.** Comparison usually involves expressing each alternative using a common metric such as net present value (NPV) or benefit-cost ratio (B/C).



- **Analyze the results and reevaluate alternatives.** Results should be scrutinized for the most influential costs, factors and assumptions. A sensitivity analysis is often used to do this. Original design strategy alternatives should be reevaluated base on these results analysis in order to improve the cost-effectiveness of each alternative

III. METHODOLOGY

Procurers to end user generally wish to lower the cost and increase the profit. Hence the main problem arising in minimizing the expected total life cycle cost considering with all cost associated with life of road. Main drawback at time of choosing alternative is that considering only initial price with little or no consideration of operation, maintenance cost and energy cost. To overcome this we have to calculate LCC at base date considering time value of money and investing most cost efficient solution to the road at initial stage. This analysis will help us to reduce LCC of structure and gives better saving through the life of road. For further analysis, Evaluating the initial construction cost for one kilometre of both flexible and rigid pavement, estimating future maintenance and rehabilitation costs, and time-saving costs of secondary data, the life cycle cost analysis (LCCA) for both pavements by the present value method for a 20-year analysis period

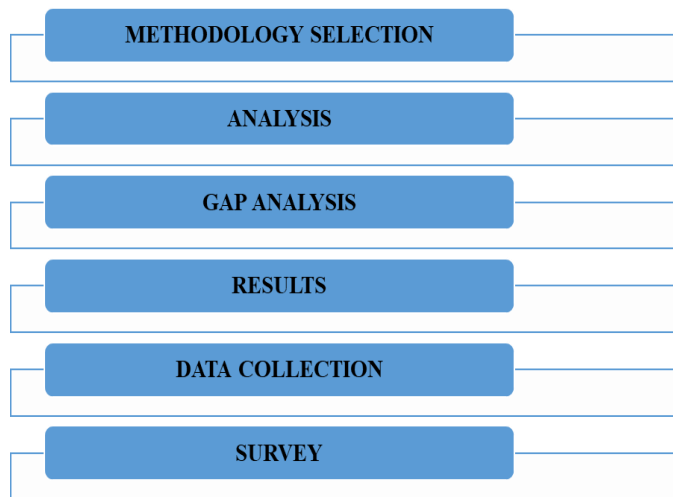


Fig 3 Flow Chart

IV. ANALYTICAL STUDY

4.1 LCCA of Rigid Pavement over Flexible Pavement Cost 2 lane

| 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 |
| | 2023 | 0.47 | 0.42 | Initial Construction cost is high for Rigid Pavement by 10.14% |
| | 2024 | 1.78 | 1.62 | |



| | | | | |
|------|------|------|-------|---|
| 1.00 | 2025 | 4.24 | 3.85 | |
| 2.00 | 2026 | 4.25 | 3.86 | |
| 3.00 | 2027 | 4.25 | 3.87 | |
| 4.00 | 2028 | 4.25 | 3.88 | |
| 5.00 | 2029 | 4.26 | 3.88 | |
| 6.00 | 2030 | 4.26 | 13.53 | Break-even point |
| 7.00 | 2031 | 4.26 | 13.54 | |
| 8.00 | 2032 | 4.27 | 13.54 | |
| 9.00 | 2033 | 4.27 | 13.55 | |
| 10.0 | 2034 | 4.27 | 13.55 | |
| 11.0 | 2035 | 4.27 | 20.54 | |
| 12.0 | 2036 | 4.27 | 20.55 | |
| 13.0 | 2037 | 4.28 | 20.55 | |
| 14.0 | 2038 | 4.28 | 20.55 | |
| 15.0 | 2039 | 4.28 | 20.56 | |
| 16.0 | 2040 | 4.28 | 36.80 | |
| 17.0 | 2041 | 4.28 | 36.80 | |
| 18.0 | 2042 | 4.28 | 36.81 | |
| 19.0 | 2043 | 4.29 | 36.81 | |
| 20.0 | 2044 | 4.29 | 36.81 | |
| 21.0 | 2045 | 4.29 | 41.20 | |
| 22.0 | 2046 | 4.29 | 41.20 | |
| 23.0 | 2047 | 4.29 | 41.20 | |
| 24.0 | 2048 | 4.29 | 41.20 | |
| 25.0 | 2049 | 4.29 | 41.21 | |
| 26.0 | 2050 | 4.29 | 44.38 | |
| 27.0 | 2051 | 4.29 | 44.39 | |
| 28.0 | 2052 | 4.29 | 44.39 | |
| 29.0 | 2053 | 4.29 | 44.39 | |
| 30.0 | 2054 | 4.30 | 44.39 | Life cycle cost for rigid pavement is cheaper by - 90.31% |

4.2 LCCA of Rigid Pavement over Flexible Pavement Cost 4 lane

| 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 |
| | 2023 | 0.93 | 0.85 | Initial Construction cost is high for Rigid Pavement by 10.14% |
| | 2024 | 3.56 | 3.23 | |
| 1.00 | 2025 | 8.49 | 7.70 | |
| 2.00 | 2026 | 8.49 | 7.72 | |
| 3.00 | 2027 | 8.50 | 7.74 | |
| 4.00 | 2028 | 8.51 | 7.75 | |
| 5.00 | 2029 | 8.51 | 7.77 | |

| | | | | |
|-------|------|------|-------|---|
| 6.00 | 2030 | 8.52 | 17.42 | Break-even point |
| 7.00 | 2031 | 8.53 | 17.43 | |
| 8.00 | 2032 | 8.53 | 17.44 | |
| 9.00 | 2033 | 8.54 | 17.45 | |
| 10.00 | 2034 | 8.54 | 17.46 | |
| 11.00 | 2035 | 8.54 | 24.45 | |
| 12.00 | 2036 | 8.55 | 24.46 | |
| 13.00 | 2037 | 8.55 | 24.47 | |
| 14.00 | 2038 | 8.56 | 24.47 | |
| 15.00 | 2039 | 8.56 | 24.48 | |
| 16.00 | 2040 | 8.56 | 40.72 | |
| 17.00 | 2041 | 8.57 | 40.73 | |
| 18.00 | 2042 | 8.57 | 40.74 | |
| 19.00 | 2043 | 8.57 | 40.74 | |
| 20.00 | 2044 | 8.57 | 40.75 | |
| 21.00 | 2045 | 8.58 | 45.13 | |
| 22.00 | 2046 | 8.58 | 45.14 | |
| 23.00 | 2047 | 8.58 | 45.14 | |
| 24.00 | 2048 | 8.58 | 45.15 | |
| 25.00 | 2049 | 8.58 | 45.15 | |
| 26.00 | 2050 | 8.58 | 48.33 | |
| 27.00 | 2051 | 8.59 | 48.33 | |
| 28.00 | 2052 | 8.59 | 48.33 | |
| 29.00 | 2053 | 8.59 | 48.34 | |
| 30.00 | 2054 | 8.60 | 48.34 | Life cycle cost for rigid pavement is cheaper by - 82.21% |

V. CONCLUSION

- 1) LCCA concludes that concrete pavements are more beneficial than bituminous pavements and concrete overlays can be considered as beneficial option for rehabilitation of existing bituminous pavements.
- 2) Based on the results of the research study, it was found out that the rigid pavement has longer service life (more than twice) than the flexible pavement. For one (1km) kilometer road length of 2 Lane road, Life cycle cost for rigid pavement is cheaper by 9.69% than bituminous pavements.
- 3) For one (1km) kilometer road length of 4 Lane road, Life cycle cost for rigid pavement is cheaper by 17.79% than bituminous pavements.
- 4) Flexible pavements can be constructed and maintained quickly and hence reduces congestion. These pavements are generally black in colour which offer significant reduction in road surface glare and assist in making line markings stand out in contrast to the road. These pavements are durable, safe and long lasting compared to rigid pavement.

REFERENCES

- 1) Ralph A. Moyer et. al. "A Study of Annual Costs of Flexible and Rigid Pavements for State Highways In California" Paper sponsored by Committee on Highway Costs
- 2) Yonas Ketema "Cost and Benefit Analysis of Rigid and Flexible Pavement: A Case Study at Chancho –Derba-Becho Road Project" International Journal of Scientific & Engineering Research, Volume 7, Issue 10, October-2016
- 3) H. A. P. Audu "Sensitivity Analysis On Flexible Road Pavement Life Cycle Cost Model" Nigerian Journal of Technology (NIJOTECH) Vol. 35, No. 2, April 2016
- 4) Mr. Akhai Mudassar Mohammed Shafi "Life Cycle Cost Analysis Of Road Pavements In Rural Areas" ISSN Vol. 5 , Issue 08, August 2016
- 5) Pooja B. Kale et. al. "Life Cycle Cost Analysis Of Rigid And Flexible Pavements" IJATES (2016)



|| Volume 12, Issue 6, June 2023 ||

| DOI:10.15680/IJIRSET.2023.1206105 |

- 6) Ralph A. Moyer et. al. "A Study of Annual Costs of Flexible and Rigid Pavements for State Highways In California" Institute of Transportation and Traffic Engineering, University of California
- 7) [Greg White](#) et. al. "Comparing the Cost of Rigid and Flexible Aircraft Pavements Using a Parametric Whole of Life Cost Analysis" University of the Sunshine Coast
- 8) Priyesh Gour et. al. "Pavement Life Cycle Cost Analysis: Review And Analysis By Meta Computing Techniques" International Journal Of Core Engineering & Management Volume-6, Issue-9, 2020
- 9) Adam Kristowski et. al. "The rigid and flexible road pavements in terms of life cycle costs" Creative Construction Conference 2018
- 10) Omar Faruq Hamim et. al. "Suitability of pavement type for developing countries from an economic perspective using life cycle cost analysis" International Journal of Pavement Research and Technology April 2020
- 11) Binginapalli Hussainbhi et. al. "An Analytical study on flexible pavement and rigid pavement design of a Road" International Journal of Research in Engineering and Science (IJRES) 2021



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