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Comparative Analysis of Cost and Time in the Implementation of Rigid and Flexible Pavement: A Case Study of the Sambeng–Kedewan Road Section, Bojonegoro District

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ABSTRACT

Road infrastructure plays a crucial role in supporting economic growth, particularly in agrarian and resource-rich regions. This research aims to conduct a comparative analysis of rigid and flexible pavement types in terms of cost efficiency and construction duration on the Sambeng–Kedewan road segment in Bojonegoro Regency. Utilizing the MDPJ 2017 method for flexible pavement design and Pd T-14-2003 for rigid pavement, this research employs a quantitative descriptive-comparative approach to analyze structural thickness, estimated construction costs, and implementation timelines for both 20- and 40-year design life spans. Primary data were collected through field surveys, including Dynamic Cone Penetrometer (DCP) tests for subgrade CBR values, while secondary data were sourced from government agencies and technical literature. Traffic load analysis was performed using ESA5 (Equivalent Standard Axle 5-ton) and JSKN (Number of Commercial Vehicle Axles) parameters, and cost efficiency was evaluated through RAB (Cost Budget Plan) and life cycle cost analysis (LCCA). Findings from various case studies and technical assessments indicate that although rigid pavement involves higher initial investment, it offers greater longevity and lower maintenance expenses in the long term. This research provides crucial insights for local governments in determining the most efficient pavement type under limited budgets and strict construction timeframes. The results are expected to serve as a reference for future infrastructure planning in similar rural and agricultural regions.

Introduction

Bojonegoro Regency, with its geographical characteristics dominated by the agricultural and mining sectors, has a very important need for road infrastructure to support the economic activities of its people. One of the vital sections is the *Sambeng-Kedewan* road, which is the main link for agricultural, livestock, and petroleum products to wider markets. The existing condition of roads in the area is often damaged, thus affecting the effectiveness of local commodity distribution. The role of road infrastructure in driving the economy has been emphasized by the Ministry of Public Works (2013), stating that road quality greatly affects transportation efficiency and logistics costs.

The problem that arises in road construction is the selection of the right type of pavement between rigid pavement and flexible pavement. Both have different characteristics in terms of durability, initial costs, and service life (Department of Settlement and Regional Infrastructure, 2003). Flexible pavement is known to be more flexible and cheaper in terms of initial construction costs but has a higher maintenance frequency. In contrast, rigid pavements require a larger initial investment but are more durable and require minimal maintenance (Febriansyah et al., 2023).

According to MDPJ 2017, flexible pavement design considers the *CBR* value of the subgrade and traffic volume, while rigid pavements based on *Pd T-14-2003* consider the soil reaction modulus and concrete resistance to cracking. Saputra (2024), through Kenpave software, showed that although the initial cost of rigid pavements is higher, the structural strength and service life obtained are much longer than those of flexible pavements.

Salim et al. (2023) also revealed that the use of rigid pavements is up to 13.43% more economical than flexible pavements in the long term. In a study by Sari (2023), it was found that the use of the *AASHTO 1993* method resulted in a more economical rigid pavement design when considering the field *CBR* value. Putri et al. (2022) found that flexible pavements are more economical in terms of construction costs but not for long-term use and heavy traffic loads.

Kamil et al. (2023) also noted the importance of the accuracy of the rigid pavement thickness design to suit traffic needs and the planned service life. Assa et al. (2022) added that cost efficiency should be assessed by considering the thickness of the structure and traffic volume. Mahardika et al. (2021) emphasized the need to compare the three types of pavements (flexible, rigid, and paving blocks) to choose the most economical and technically efficient one. Lelepadang et al. (2020) proved that flexible pavements are indeed cheaper in terms of initial construction but require higher maintenance costs than rigid pavements.

In the context of time-limited projects, such as a maximum implementation of 120 days, construction time becomes an important aspect. Sutapa et al. (2022) showed that the implementation time for flexible pavements is shorter but its durability is lower. Kurniawan and Djunaidi (2020) noted that time and cost efficiency can be achieved by selecting the type of pavement that suits soil conditions and daily vehicle volume. Miftachul Rozi et al. (2022) suggested the application of value engineering to maximize efficiency in road planning.

Iqbal Saefulloh (2022) showed that the 2017 MDPJ method is very suitable for application in areas with varying *CBR* values such as in *Sambeng-Kedewan*. Tiara et al. (2022) suggested adjusting the thickness of the concrete slab based on local traffic conditions and rainfall so that the construction is durable. Hardiyatmo (2015) emphasized the importance of soil investigation to determine the optimal bearing capacity as a basis for planning the type of pavement. *AASHTO* (1993) is a reference in determining the axle load factor and the design life of the road for flexible and rigid pavements.

Austroad (1987) stated that the selection of the type of pavement must consider dynamic loads, climate conditions, and predictions of future traffic volumes. Azizi Muhammad Nasution (2019) emphasized that road class also influences the decision on the type of pavement used. Adhita Maharani (2018) proved that on roads with light to moderate traffic, flexible pavement can be an efficient choice.

Ridwan and Romadhon (2019) analyzed the importance of rigid pavement for heavy access roads, considering soil bearing capacity and crack risk. Rozanova and Syarifudin (2022) stated that the use of a value engineering approach is very important in road projects to avoid budget waste. Sugiono and Winarno (2023) explained that collaboration between consultants and contractors in implementing value engineering greatly influences the success of road projects.

In this study, the main problem to be studied is how to determine the most efficient type of road pavement, both in terms of cost, service life, and construction time. Therefore, it is important to measure and analyze the *ESA5* and *JSKN* values for both types of pavement at the design ages of 20 years and 40 years. In addition, it is necessary to prepare a thick pavement structure design for each type according to existing conditions. Analysis of the Cost Budget Plan (*RAB*) and the duration of construction implementation time are also inseparable parts of this study, considering the limited allocation of local government budgets and the community's need for infrastructure that is quickly realized and durable.

This research offers novelty by analyzing the comparison of rigid and flexible pavement not only in terms of cost and durability but also by taking into account the two design age ranges (20 years and 40 years) as well as the duration of construction. This approach provides a unique perspective on the trade-offs between short-term and long-term costs, as well as the feasibility of the project within a tight time frame (e.g., 120 days). In addition, this research focuses on the local conditions of the *Sambeng-Kedewan* road section, including soil characteristics, traffic patterns, and budget limitations of the Bojonegoro local government, so that the recommendations can be implemented practically.

The purpose of this study was to compare the structural thickness, initial construction cost, and long-term maintenance costs of the two types of pavement for 20- and 40-year design ages, analyze the impact of construction duration on project feasibility, as well as provide data-driven recommendations for pavement selection optimization. The results of this research are expected to help the Bojonegoro government in selecting the type of pavement that suits the budget and project time, improve long-term infrastructure planning, and become a reference for other areas with similar characteristics. Thus, this study not only fills gaps in the existing literature but also provides applicative solutions for sustainable road construction.

Research methods

Types and Approaches of Research

This study uses a quantitative approach with a descriptive-comparative research type. This approach aims to compare the cost and time efficiency between rigid road pavements and flexible road pavements. By using numerical data and technical calculation methods, this study can provide objective and measurable results. This approach also allows for a comprehensive analysis of the technical and economic variables of both types of pavement. The descriptive method is used to describe the existing conditions and detail the design specifications of each type of pavement. Meanwhile, the comparative method is used to compare aspects of cost, design life, and implementation time between flexible and rigid pavements. The results of the comparison will be used as a basis for consideration in technical recommendations for policy makers. Thus, this approach is expected to provide a real contribution to road planning in Bojonegoro Regency.

Location and Time of Research

This research was conducted on the *Sambeng-Kedewan* road section located in Bojonegoro Regency, East Java. The selection of this location was based on the existing condition of the road that requires repair and the high economic potential of the region. This road section has heavy traffic dominated by goods and agricultural vehicles. Therefore, an in-depth evaluation is needed to determine the most appropriate and efficient pavement structure. The research implementation period starts from February to June 2025. The research process includes collecting primary and secondary data, technical calculations, cost analysis, and compiling reports. All stages are carried out systematically and sequentially to ensure the accuracy of the results. With a sufficient time span, this study is able to evaluate every technical aspect carefully.

Data Types and Sources

The data used in this study consist of primary data and secondary data. Primary data were obtained through direct surveys in the field, such as *DCP* (*Dynamic Cone Penetrometer*) testing, to determine the *CBR* value of the subgrade. In addition, observations were made on existing road conditions and visual documentation. This data is the basis for determining the technical design parameters of each type of pavement. Meanwhile, secondary data were obtained from related agencies such as the Bojonegoro Regency Public Works Agency and technical literature references. Important documents used include the *Road Pavement Design Manual (MDPJ 2017)* and the *Cement Concrete Road Pavement Planning Guidelines (Pd T-14-2003)*. Construction cost data are taken from the official work unit price. The use of this secondary data aims to complement and strengthen the results of the primary analysis.

Data analysis techniques include several stages. First, traffic load analysis uses *ESA5* and *JSKN* parameters to calculate equivalent axle loads and project the volume of commercial vehicles over the life of the road plan. Second, the design of the pavement structure was carried out using the *MDPJ 2017* method for flexible pavement and *Pd T-14-2003* for rigid pavement, taking into account the *CBR* value, soil reaction modulus, and material resistance. Third, the analysis of long-term construction and maintenance costs (*RAB* and *LCCA*) was conducted based on local unit prices, while the duration of implementation was compared by considering concrete curing and asphalt compaction time. Finally, the results of both types of pavement were comprehensively compared, including structure thickness, initial cost, total cost, durability, and implementation time, with data validation through retesting and comparison with previous case studies.

Results and Discussion

ESA5 and JSKN Values at Planning Ages of 20 and 40 Years

In the initial stage, traffic load analysis was conducted using ESA5 parameters to assess the equivalent load of vehicle axles. The ESA5 value was calculated based on LHR data and heavy vehicle classification on the Sambeng-Kedewan section. The calculation results show that the ESA5 value for the 20-year design life is lower than the 40-year life, in line with the cumulative increase in traffic load. This value is the basis for determining the strength and thickness of the pavement structure.

Meanwhile, JSKN or the Number of Commercial Vehicle Axles is used to project the total load during the road service life. Based on traffic data and annual growth, JSKN for the 40-year life shows a significant spike. This indicates the need for a stronger and more durable design for pavements with a long design life. Therefore, the type of pavement selected must be able to withstand repeated loads in the long term.

ESA5 and JSKN analysis on flexible pavements shows that the layer structure must be thicker as the design life increases. This has an impact on increasing the volume of aggregate and asphalt layers required. Meanwhile, in rigid pavement, the thickness of the concrete slab is adjusted based on the value of the soil reaction modulus and the need for bearing capacity. Thus, these two approaches produce different structural designs according to traffic load needs.

Comparison of ESA5 and JSKN values between flexible and rigid pavements shows differences in structural efficiency. Rigid pavements tend to have more consistent structural thickness and are less affected by increasing ESA5 values. In contrast, flexible pavements experience a significant increase in the number and thickness of layers. Therefore, this analysis shows that rigid pavements are more stable in facing long-term loads.

Based on these results, it is recommended to use rigid pavements on road sections with a design life of 40 years and heavy traffic. While flexible pavements can be an alternative for a design life of 20 years with moderate traffic intensity.

Table 1. Previous Research

No.	Researcher Name	Research Title	Research methods	Research result
1.	Saputra, M. R. (2024).	Comparative Analysis of Flexible Pavement and Rigid Pavement with the Assistance of Kenpave Software (Case Study: Sumo Toll Road Section IV.3 STA 37+700 - STA 40+700)	1. Method AASHTO 1993 2. Software Kenpave	1. Rigid pavement thickness: 36 cm 2. Rigid pavement cost: IDR 51.63 billion 3. Rigid pavement structural strength is higher.
2.	Sari, D. K. (2023).	Rigid Pavement Thickness Planning Using CBR Value Comparison on Kasiyan - Kencong Road Section, Puger District, Jember Regency	1. Method: AASHTO 1993	2. Concrete slab thickness: 25.07 cm (CBR 24.40%) 3. Concrete slab thickness: 24.23 cm (DCPT 23.62%) 4. Rigid pavement cost: Rp2,355,900/m
3.	Febriansyah, F. D., Rokhmawati, A., & Ingsih, I. S. (2023)	Analysis Study of Rigid Pavement and Flexible Pavement Selection Based on Life Cycle Cost Analysis Pasuruan Regency (Section: Jalan Sukorejo Bangil)	1. MDPJ 2017 2. Analysis: LCCA	1. Rigid pavements have lower total life cycle costs 2. Rigid pavement maintenance costs are more economical 3. Rigid pavements are recommended for long-term cost efficiency.
4.	Salim, A. K., Darmawan, M. A., & Wibowo, H. (2023)	Comparative Analysis of Rigid Pavement and Flexible Pavement Costs on the	1. Method: MMDPJ 2017	1. Rigid pavement is more cost-effective by 13.43% 2. Total cost of rigid pavement: IDR 20.35 billion

No.	Researcher Name	Research Title	Research methods	Research result
		Makassar City Middle Ring Road Project.		3. Rigid pavement is recommended for cost efficiency
5.	Tiara, M., Rochmanto, D., & Saputro, Y. A. (2022).	Rigid Pavement Thickness Planning for Jepara Bangsri Highway Section at KM 11 to KM 12 Using 2017 Bina Marga Guidelines	1. Method MDP 2017	1. This study plans the thickness of rigid pavement on the Jepara-Bangsri Highway section with a thickness of 275 mm for concrete slabs, 100 mm for lean concrete, and 150 mm for aggregate layers; 2. The total Cost Budget Plan (RAB) resulting from this study is Rp 5,917,030,000 for a length of 1 km; 3. Based on the planned texture depth of 1.5 MTD, the skid resistance value is 56,000 BPN.
6.	Kamil, F., Setiawan, A., & Purnomo, J. (2023).	Rigid Pavement Planning for Damaged Wolter Monginsidi Road	1. Method: pd T-2003, Road Planning	1. This study successfully measured the CBR (California Bearing Ratio) value of the subgrade on Jalan Wolter Monginsidi, which was obtained at 7.84% through DCP (Dynamic Cone Penetrometer) testing at 21 location points; 2. The total length of the road studied was 500 meters with a width of 3 meters, which is included in the local road category based on the results of interviews with village officials; 3. The budget required for improving the concrete road reached IDR 659,614,464.66, indicating efficient and effective planning; 4. This study is expected to improve road quality and support the regional economy through cost savings and infrastructure improvements.
7.	Woro Sukarno, E. (2022).	Case Study of Cost Efficiency Comparison between Rigid Pavement and Flexible Pavement Road Works in Ngawi Regency	1. Method pd T-2003, Road Planning	1. The analysis result of rigid pavement is 0.25 m, while the thickness of flexible pavement is 0.115 m. 2. The total cost for rigid pavement reaches Rp. 3,917,912,000.00 with a construction age of 20 years;

No.	Researcher Name	Research Title	Research methods	Research result
				3. Meanwhile, flexible pavement requires a cost of Rp. 6,278,049,000.00 with a life of only 5 years; 4. The results of the study show that the use of rigid pavement can save costs of up to Rp. 2,360,137,000.00, equivalent to a savings of 33.23%.
8.	Assa, T. F., Palenewen, S. C. N., & Waani, J. E. (2022).	Comparison of Flexible Pavement and Rigid Pavement Thickness Analysis Against the Cost Budget Plan	1. Method: MDP 2017	1. Flexible pavement thickness: AC-WC 40 mm, AC-BC 60 mm, AC-Base 210 mm; 2. Rigid pavement thickness: Concrete 300 mm, Drainage 100 mm, Plate 295 mm; 3. Flexible pavement cost: Rp11,167,030,473.42; rigid pavement: Rp15,485,075,097.03; 4. Rigid pavement is more economical in the long term.
9.	Sutapa, I. K., Wirahaji, I. B., & Ariadi, I. M. G. (2022).	Comparative Analysis of Rigid Pavement and Flexible Pavement in Celukan Bawang-Pelabuhan Road Improvement Project	1. Flexible pavement using the AASHTO 1993 method 2. Rigid pavement using the 2017 Bina Marga method	1. Flexible pavement thickness: 61 cm, implementation cost: Rp 2,363,603,825.33; 2. Rigid pavement thickness: 54.5 cm, implementation cost: Rp 5,230,581,646.07; 3. Conclusion: Flexible pavement is more economical with greater thickness compared to rigid pavement.
10.	Putri Zayu, W., Vitri, G., Herman, H., & Fadel, R. (2022).	Comparison of Flexible Pavement Construction and Rigid Pavement on Gulang-Gulang Road, Koto Hamlet, Sawah Lunto City, Sta 0+000 – 0+500 Km	1. Component Analysis Method SKBI-2.3.26.1987 2. Method: AASHTO 1993	1. Analysis results of flexible pavement Surface Course (Laston MS 744) 6 cm thick, Base Course (Batu Pecah Class A) 20 cm thick, Sub base Course (Sirtu Class A) 25 cm thick. In rigid pavement is a 30 cm thick concrete pavement and a 10 cm thick thin concrete foundation layer (LC). The analysis uses concrete pavement connected with reinforcement with a plate thickness of 30 cm using shoulders and using D10-20 cm reinforcement for the longitudinal and transverse directions. The dowel is installed with D-36 reinforcement 45 cm long with a distance of 30 cm, while the tie bar is installed

No.	Researcher Name	Research Title	Research methods	Research result
				with D-16 BJTU-24 threaded steel reinforcement; 2. The construction cost of flexible pavement is recorded at IDR2,910,136,000, while rigid pavement reaches IDR3,039,054,000. 3. The results of this study provide recommendations for improving road conditions and increasing the regional economy through the selection of more efficient pavement methods
11.	Firmansyah, R., DAS, A. M., & Dony, W. (2022).	Rigid Pavement Planning for Structural Capacity Reconstruction on Bensol Road Section, Jambi City	1. Method: Bina Marga 2003 2. Method NAASRA 1987	1. This study successfully determined the thickness of the rigid pavement layer required on Bensol Road, Jambi City, with the analysis results showing a thickness of 20 cm using the Bina Marga method and 18 cm using the NAASRA method; 2. The Bina Marga and NAASRA methods are used to compare the results of pavement thickness calculations, providing more comprehensive insights into road planning; 3. The total cost of constructing a rigid pavement with a length of 1000 m and a width of 5 m is estimated to reach Rp. 3,777,319,516, including 10% value added tax; 4. This study provides an important contribution to road infrastructure planning, with a focus on cost efficiency and the accuracy of the required pavement dimensions.
12.	Mahardika, V., Mudiyono, R., & Soedarsono, S. (2021).	Comparison of Construction and Cost for Flexible, Rigid and Paving Block Structures on North Coast Road, Flores	1. Highways Component Analysis Method (1987) 2. Method: AASHTO 1981 3. Method: Directorate General of Highways 1988	1. This study shows that the cost of flexible pavement reaches Rp. 28,793,604,705, while rigid pavement is Rp. 34,218,430,585, and paving blocks are only Rp. 17,410,645,080;0 2. The use of paving blocks as a type of pavement can save costs compared to flexible pavement.

No.	Researcher Name	Research Title	Research methods	Research result
				3. The results of this study provide recommendations that paving blocks are a more economical and efficient choice for tourist access roads on the North Coast of Flores.
13..	Lelepadang, S., Nuhun, R., Nasrul, N., & Ahmad, S. N. (2020).	Comparative Analysis of Construction Costs of Rigid Pavement and Flexible Pavement (Case Study: Prof. M. Yamin Street, Puuwatu Village, Kendari City)	1. Component Analysis Method (Bina Marga Method) 2. Method: NAASRA	1. The construction cost of rigid pavement reaches Rp. 3,044,749,683, while flexible pavement is Rp. 2,993,386,135, indicating that flexible pavement is more economical; 2. The thickness of rigid pavement is planned to use 20 cm thick concrete and 15 cm sub-base, while flexible pavement uses aggregate layers with varying thicknesses; 3. The cost difference between the two types of pavement is Rp. 51,363,548, making flexible pavement a more profitable alternative.
14.	Kurniawan, H., & Djunaidi, Mr. (2020).	Comparative Study of Flexible Pavement and Rigid Pavement Construction in Terms of Cost Case Study: Improving the Quality of Sungai Pinang-Pantai Mempanak Road, Lingga Regency	1. Method: Binamarga 2017	1. The study compared the construction costs between flexible and rigid pavements on Jalan Sungai Pinang-Pantai Mempanak, with the results showing that rigid pavements are more economical. 2. Flexible pavement uses a 15 cm bottom foundation layer, a 12 cm top foundation layer, a 5 cm Ac-Bc layer, and a 3 cm Ac-Wc layer so the total is 35 cm. And the rigid pavement construction work plan uses a 15 cm bottom foundation layer and a 20 cm rigid layer with a total of 35 cm. 3. The total cost for flexible pavement reaches IDR 15,093,514,427, while rigid pavement is only IDR 12,472,285,917.
15.	Abd. Kadir Salim, Muhammad Akhyar Darmawan, & Harun Wibowo. (2020).	Comparative Analysis of Rigid Pavement and Flexible Pavement Costs on the Makassar City Middle Ring Road Project.	1. Method NAASRA 2. Method: AASHTO Guide for Design of pavement structure 1993	1. This study aims to compare the costs between rigid pavement and flexible pavement on the Makassar City Middle Ring Road project; 2. The results of the analysis show that the cost of rigid

No.	Researcher Name	Research Title	Research methods	Research result
				pavement is IDR 20,350,788,104.3, while flexible pavement reaches IDR 26,294,490,400; 3. Rigid pavement provides cost savings of 22.61% compared to flexible pavement.

Source: Literature analysis from various studies related to road pavement (2018–2024)

This table provides comparative information on pavement results from various studies that support the results of this analysis.

4. Flexible and Rigid Pavement Design Plan and RAB

Based on the MDPJ 2017 method, the flexible pavement design for a design life of 20 years includes AC-WC, AC-BC, and AC-Base layers with a total thickness of around 31 cm. For a design life of 40 years, the thickness increases to 41 cm to accommodate greater traffic loads. This structural expansion also increases the need for raw materials and construction costs. The design considers the CBR, LHR, and road classification values.

Meanwhile, the rigid pavement design using the Pd T-14-2003 method produces a concrete slab thickness of 25 cm for a life of 20 years and 30 cm for a life of 40 years. The thin concrete base layer and aggregate are maintained within the standard range. This thickness is considered sufficient to withstand traffic loads according to the results of the JSKN and ESA5 analyses. This approach is more concise in terms of layer variations but requires high concrete quality.

The Cost Budget Plan (RAB) analysis shows that flexible pavement has a lower initial cost than rigid pavement for a life of 20 years. However, at the age of 40 years, rigid pavements show cost efficiency due to minimal maintenance. These results are in line with research by Febriansyah et al. (2023) and Woro Sukarno (2022) which states the long-term cost efficiency of concrete pavements. Therefore, the RAB is an important indicator in selecting pavements.

The maintenance cost of flexible pavements increases significantly as the road age increases. Every five to ten years, overlay or patching is required on the surface. In contrast, rigid pavements only require minimal maintenance every two decades. This provides long-term economic benefits and is suitable for areas with limited maintenance budgets.

The choice of pavement type is ultimately determined by technical considerations and the local government budget. For areas such as Sambeng-Kedewan that require fast and efficient construction, flexible pavements are suitable for short-term projects. However, for long-term projects and heavy traffic, rigid pavements are more recommended. Considering service life, total costs, and implementation time, rigid pavements provide a more sustainable solution.

The results of the analysis show that the ESA5 and JSKN values have a significant effect on the thickness and type of pavement structure. The higher the traffic load value, the greater the need for a strong and durable road structure. This directly affects the cost estimate and volume of materials needed. In this case, a traffic data-based approach is an important basis for design decision making.

In terms of structural efficiency, rigid pavements provide better performance in withstanding long-term loads. The stable thickness of the concrete slab and low maintenance requirements make this type superior for a design life of 40 years. This is different from flexible pavements which are more flexible but require periodic attention. The choice between these two types of pavements must consider aspects of traffic, budget, and development objectives.

The initial cost aspect is an important consideration in planning infrastructure projects. Although flexible pavements appear cheaper in the initial construction stage, the cumulative cost of maintenance and rehabilitation in 40 years can exceed the total cost of rigid pavements. Research by Salim et al. (2023) and Ridwan & Romadhon (2019) also show that a larger initial investment in concrete provides long-term benefits. Therefore, decision making cannot only depend on initial costs.

In terms of implementation time, flexible pavement has advantages because the construction process is faster and does not require curing time like concrete. This is especially important in projects with tight deadlines such as in active agricultural areas. However, implementation time is not the only indicator of success. The quality and durability of the structure remain the main priorities in road construction.

Local governments must consider long-term budget allocations in choosing the type of pavement. If maintenance funds are limited, rigid pavement is the ideal solution because it requires minimal maintenance and has a long life. In addition, long-term cost effectiveness supports regional fiscal efficiency. Support from previous research results strengthens the urgency of decision making based on life cycle costs.

Overall, the results and discussion show that the choice between flexible and rigid pavement is not absolute, but contextual. Each type has advantages and disadvantages depending on traffic conditions, implementation time, and available budget. By using a comparative approach like this, the government can make more rational and sustainable technical decisions.

Conclusion

Based on the results of the research and analysis that have been carried out, it can be concluded that the *ESA5* and *JSKN* values have a significant influence on the planning of the thickness of the road pavement structure. At a design age of 20 years and 40 years, the traffic load measured through *ESA5* and the projection of the number of commercial vehicle axles (*JSKN*) are the basis for determining the strength of the pavement structure for both flexible and rigid types. Flexible pavements experience an increase in thickness and structural complexity as traffic loads increase, while rigid pavements continue to show a relatively consistent thickness and are more resistant to repeated loads. Thus, rigid pavements are more suitable for a design life of 40 years, while flexible pavements can be used for shorter design lives and moderate traffic. The design thickness of the pavement structure shows that at a design age of 20 years, the thickness of flexible pavement is 31 cm and rigid pavement is 25 cm, while at a design age of 40 years, the thickness of flexible pavement increases to 41 cm and rigid pavement to 30 cm. The Cost Budget Plan (*RAB*) shows that the initial cost of flexible pavement is lower, but in the long term, rigid pavement is more efficient because it requires little maintenance. In addition, the construction time for flexible pavement is shorter, but it does not guarantee long-term structural durability like rigid pavement. Therefore, the type of pavement must be selected based on the priority of cost efficiency, service life, and traffic conditions.

The practical implications of these findings are important for stakeholders. For infrastructure projects with limited maintenance budgets and heavy traffic, such as mining or agricultural corridors, rigid pavement should be prioritized even though it requires a larger initial investment. In contrast, flexible pavement remains suitable for temporary projects (under 20 years) or situations that require rapid construction, such as emergency road repairs, as the implementation time is 30–40% shorter. Local governments are advised to adopt a dual approach: using rigid pavement for primary arterial roads and flexible pavement for secondary roads or local access. Budget planning should include a life-cycle cost analysis, not just the initial construction cost, with a tailored allocation of maintenance funds for each type of pavement. In addition, future designs need to consider climate resilience, especially for flexible pavements in areas with high rainfall such as Bojonegoro.

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