

# Evaluating The Performance of Reclaimed Asphalt Pavement (Rap) As A Sustainable Option for Rural Road Construction

Manish Kumar<sup>1</sup>, Hirendra Pratap Singh<sup>2</sup>

<sup>1</sup>Research Scholar, <sup>2</sup>Assistant Professor

Department of Civil Engineering, School of Research and Technology, People's University, Bhopal, India

**Abstract:** The primary goal of this research work is to growing need for sustainable and cost-effective road construction has encouraged the use of Reclaimed Asphalt Pavement (RAP) as a substitute for virgin materials. This study explores the performance of RAP in rural road construction by replacing natural aggregates and bitumen with RAP at varying levels of 10%, 20%, 30%, 40%, and 50%. Laboratory tests, including Marshall Stability, flow values, density, air voids, voids in mineral aggregates (VMA), and voids filled with bitumen (VFB), were carried out to evaluate the strength and durability of the mixes. The findings show that RAP can be effectively used up to about 30–40% without compromising pavement quality. Beyond this level, the mixes tend to lose stability and become more prone to deformation. Using RAP not only reduces construction costs but also conserves natural resources and helps address the problem of waste disposal from aged pavements. Overall, the research demonstrates that RAP is a practical and sustainable option for rural road construction, offering both economic savings and environmental benefits, while also highlighting the need for further studies on rejuvenating agents and advanced mix design methods to improve performance at higher RAP contents.

**How to cite this article:** Manish Kumar, Hirendra Pratap Singh. (2025). Optimizing the Connecting Rods for Static Structural Analysis. International Journal of Scientific Modern Research and Technology (IJS MRT), ISSN: 2582-8150, Volume-21, Issue-1, Number-1, Oct-2025, pp.01-05, URL: <https://www.ijsmrt.com/wp-content/uploads/2025/12/IJS MRT-25100101.pdf>

Copyright © 2025 by author (s) and International Journal of Scientific Modern Research and Technology Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0)

<http://creativecommons.org/licenses/by/4.0/>



IJS MRT-25100101

## I. INTRODUCTION

This study presents an extensive overview of the use of Reclaimed Asphalt Pavement (RAP) in the construction and maintenance of asphalt pavements. It begins by addressing the complexities associated with the recycling of old asphalt pavement, a process whereby aged asphalt is mechanically ground and repurposed as a substitute raw material in new pavement applications. This practice has gained traction as it demonstrates significant advantages, indicated by laboratory and field experiments that show pavement mixtures incorporating RAP often perform similarly to or outperform traditional materials in metrics such as indirect tensile strength, moisture susceptibility, permanent deformation, and fatigue resilience.

However, the chapter highlights potential drawbacks, particularly concerning the fatigue resistance of mixtures with RAP. The aging of the asphalt binder in reclaimed materials can lead to a decrease in performance when used in hot mix asphalt applications due to the loss of lighter fractions over time. To mitigate this issue, the incorporation of additional binder may enhance the properties of the mixture, rejuvenate the aged binder and restore some of its original characteristics.

In the rationale for undertaking this project, the chapter notes the significance of cost in promoting the recycling and reuse of asphalt materials, particularly in rural areas where the high cost of transportation can deter recycling efforts. The exploration of waste

bitumen highlights a concerning trend in India, where insufficient attention has been given to recycling asphalt and addressing the aging effects that impact its binding properties.

The text explains that RAP consists of bitumen-coated scrap aggregates obtained during the rehabilitation of pavements. The primary benefit of using RAP is the reduction in demand for new aggregates and bitumen, critical components in constructing flexible pavements. The section also details the heating process involved in creating hot mixes, necessary for ensuring effective blending between bitumen and aggregates.

## II. RELATED WORK

As discussed below is the literature of Reclaimed asphalt pavement (RAP) till now for asphalt mixes. Dharmesh Kumar, and Dr. R.K Pandey, (2016)-Carried out A Reappraisal Paper on Reclaimed Asphalt Pavement (Rap). Reclaimed Asphalt Pavement is a new technology of construction work with the help of which bituminous pavements can be constructed at a decreased cost as it involves the utilize of old bituminous pavement materials. Also, it ensures accumulation of resources and supports sustainable development. Optimal percentage of Reclaimed Asphalt Pavement Depends upon the mixture of reclaimed bituminous material and type of payment layer in which it is to be used. Though 25%-55% are mostly adopted.

Brajesh Mishra, (2015)-Studied Use of Reclaimed Asphalt Pavement (RAP) Materials in Flexible Pavement It was observed that the RAP materials can be successfully used in granular sub base layer of flexible pavements after blending to match the required grading as per MORTH specifications for sub base material. It was also observed that the RAP materials in combination to natural aggregate in various proportions can be easily used after blending to match the required grading as per MORTH specifications in the base courses of flexible pavements. It is clear from the above investigation results that 30% replacement of natural aggregate can be successfully done in base course of flexible pavements, resulting in a savings of around 25-30% in construction cost. Above all the problem of disposal of RAP wastes can be easily solved and adverse effect on environment may be avoided by using the RAP materials in flexible pavement construction.

Jaspreet Singh, et al., (2015)-Studied Reclaimed Asphalt Pavement (RAP) is a new technology with the help of which bituminous pavements can be constructed at a reduced cost as it involves the usage of old bituminous pavement materials. Also, it ensures optimization of resources and supports sustainable development. Optimal percentage of RAP depends upon the composition of reclaimed bituminous material and type of layer in which it is to be used. Though 20%- 50% are mostly adopted.

Edward J. Hoppe, et al., (2015)-Evaluated the Feasibility of Reclaimed Asphalt Pavement (RAP) Use as Road Base and Subbase Material. The use of RAP in road base and subbase layers is technically viable. Numerous transportation agencies have been recycling RAP in unbound base and sub-base layers for many years; however, there is a lack of literature on actual field performance. Because of concerns related to lower shear strengths and excessive permanent deformations resulting from large strains as RAP content increases, there is a general trend of using up to 50% RAP content by weight in virgin aggregate base and sub-base layers. There is a general lack of uniformity among the RAP use specifications adopted by various transportation agencies. When the nuclear density gauge is used for wet/dry density measurements, the compaction acceptance criteria need to be modified to account for the RAP content. Current pavement design procedures do not account for RAP material properties. There do not appear to be substantial e-leaching concerns related to stabilized RAP used as base or sub-base material. The use of chemical stabilization agents may require environmental assessment on a case-by-case basis.

Ahmed Mohamady, et al., (2014)-Studied the Effect of Using Reclaimed Asphalt Pavement on Asphalt Mix Performance the optimum asphalt content is decreased as the RAP percent increase. Mix stability decreases as the recycled aggregate percentage increases. This may be due to the fatigue of such materials by aging. Increasing the RAP percent from zero to 30% decreases the stability value by about 22%. However, this decrease reaches 31% when the reclaimed percentage reaches 40%.

Aravind. K and Animesh Das, (2007)-Concluded on the design of pavement of RAP with central hot mix plant. Two different RAP samples were being processed in the laboratory, the first one include the extraction of aged binder using Centrifuge Bitumen

Extractor (CBE), then the new binder was predetermined and added with the old binder such that uniform viscosity was achieved then that binder was mixed with old and virgin aggregates in the newly prepared hot mix. The second one include collection of broken RAP scrap using hammer, while detaching the RAP it should not be crushed, then the broken RAP was added with new virgin aggregates in hot mix. Marshall test and fatigue test was being conducted in the laboratory, the Marshall test with bitumen content starting from 4.5%,5.0%,5.5%,6.0% and 6.5% with average of three samples each conducted, and results were compared with the virgin Semi Dense bituminous Concrete (SDBC) as per MoRT&H. Here in this study the number of parameters was not in range and a common area of contentment is not accomplished. Thus, leading to non-establishment of Optimum binder content.

### III. PROBLEM IDENTIFICATION

- Limited adoption of Reclaimed Asphalt Pavement (RAP) in rural areas, especially in developing countries like India, leads to reliance on traditional materials, increasing costs and environmental impact.
- Insufficient technical data on RAP performance in rural settings, as most studies focus on urban roads, causing reluctance in its application.
- Variability in RAP material properties based on source, including inconsistent binder aging and aggregate contamination, creates performance unpredictability, hindering standardization.
- Concerns about long-term durability and fatigue resistance of RAP mixtures, particularly in rural areas where maintenance is minimal, pose challenges for sustainable usage.
- Lack of supportive policies, standard specifications, and affordable technologies for integrating RAP in rural infrastructure leads to missed opportunities for cost-effective and sustainable resource utilization.

### IV. RESEARCH OBJECTIVES

The following goals are suggested for the experimental effort, which is done to determine how different amounts of RAP materials affect the strength and durability of pavement:

- To recycle RAP and address the waste disposal problem.
- To evaluate bitumen and recycled aggregates' strength characteristics for different RAP

replacement percentages of 10%, 20%, 30%, 40%, and 50%. to investigate the effects of replacement and focus on future use, as well as the impact of aging on RAP hot mix asphalt.

- To ascertain the Marshall stability at the ideal bitumen content.

### V. EXPERIMENTAL WORK

Sourced from Hirasar, sizes range from 26.5 mm to 0.075 mm for DBM-II Marshall mix design; fine aggregates enhance slip resistance and reduce cracking. Water absorption should ideally be <2%; cleanliness is crucial to avoid deleterious substances; impact value must be  $\leq 27\%$  and Los Angeles abrasion  $\leq 35\%$  for toughness; durable aggregates are necessary to prevent potholes; specific gravity types include bulk, apparent, and effective. Collected from BC layer on Rajkot-Ahmedabad Road, it is reused to create stable asphalt mix for DBM-II. Utilizes centrifugal extractor with benzene; average bitumen content is 5.73%, with a process duration of 15–25 minutes.



Figure 1: Bitumen extraction using centrifugal extractor.

The resistance to breaking caused only by impact is established by the aggregate impact value test. In order to calculate the total impact value of RAP, a standard size sample measuring between 12.5 and 10 mm was loaded with 15 blows from a height of 380 mm. The sample was then allowed to pass through a sieve with a mesh size of 2.36 mm, and the loss or cumulative percentage was computed. The experiment was carried out in accordance with IS: 2386 (Part IV). The hammer weighed around 14 kg, and the cup was 50 mm tall and 102 mm in diameter. A RAP sample was put inside the cup.



Figure 2: Aggregate impact value (AIV %) test on RAP

The loss of volatiles in the aged RAP binder causes the penetration to decrease as the amount of RAP binder increases. Virgin bitumen has a penetration value of 65 mm. For every RAP binder proportion, penetration falls as RAP% rises; after long-term ageing, the lowest penetration value for 100% RAP bitumen is 30mm.

Table 1: Variation of Penetration Values for Different Percentage of RAP

PENETRATION(MM)	RAP
65	0
61	10
56	20
51	30
47	40
44	50

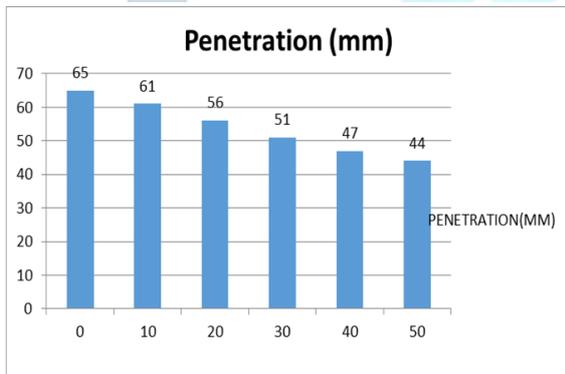


Figure 3: Variation of Penetration Values for Different Percentage of RAP

## VI. RESULTS AND DISCUSSION

Result given in table 2 diagram is plotted. It is seen from Figure-4.1 that as we increment the RAP content then also required bitumen% for required density, stability, and other results.

Table 2: RAP% Vs Bitumen%

Sample No	RAP %	Bitumen %
1	10	4.6

2	20	4.75
3	30	4.8
4	40	4.9
5	50	5.1

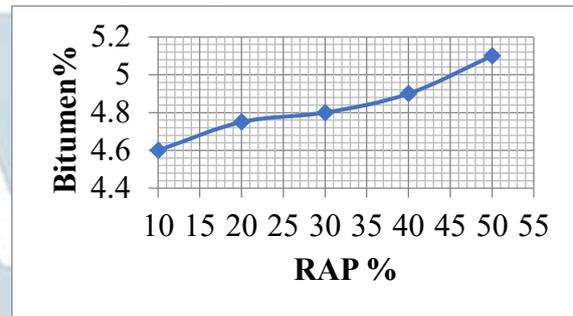


Figure 4: RAP% Vs Bitumen

RAP % increase then density decrease.

Table 3: RAP% Vs Density

Sample No	RAP %	Density
1	10	2.520
2	20	2.522
3	30	2.521
4	40	2.523
5	50	2.515

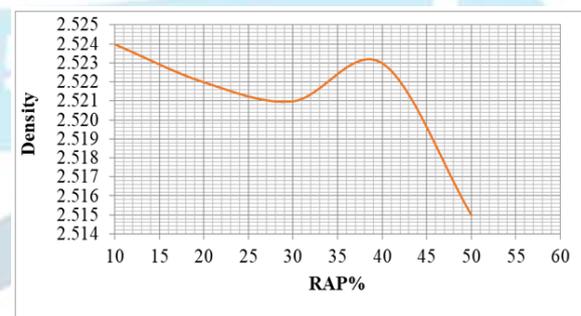


Figure 5: RAP% Vs density.

The graph is plotted using the results shown in Table 3. Figure 5 shows that the dependability estimation of the bituminous solid example first increases and then decreases as the bitumen concentration increases. The expansion of the flow value is the cause of this.

## VII. CONCLUSION

The study focuses on the objective identification and characterization of Reclaimed Asphalt Pavement (RAP) material, emphasizing the optimal integration of RAP binder with virgin binder and the recycling of RAP aggregates for use in asphalt and subbase layers. It is found that RAP materials, when blended to comply with the grading requirements set by the Ministry of Road Transport and Highways (MORTH), can be effectively utilized in the granular sub-base layers of flexible pavements, promoting both economic and sustainable practices in asphalt recycling.

The research also determines that the Marshall Solidness test reveals an optimal bitumen content of 5.1%, with the Marshall Stability value increasing up to this point before experiencing a decline. Notably, as the percentage of RAP increases, the Marshall Flow value decreases. At a RAP content of 50% with a consistent bitumen composition of 5.1%, the maximum Marshall Stability value recorded is 961 kg, but it is noted that the stability value decreases by 50% beyond this threshold.

Looking towards the future, the study asserts that RAP can be effectively utilized in the construction of rural roads or those with low traffic intensity. With multiple studies backing this, it is proposed that up to 50% of natural aggregate in the base course of flexible pavements can be replaced with RAP, leading to a significant reduction in construction costs, estimated between 40% and 50%. This approach not only lowers project costs but also ensures efficient resource utilization.

## REFERENCES

- [1] Ahmed Mohamady, Ashraf Elshahat, Mahmoud Fathy Abd-Elmaksoud, Mohamed Hoseny Abdallah, "Effect of Using Reclaimed Asphalt Pavement on Asphalt Mix Performance" 2014, 16 (6): 55-76
- [2] Al-Hadidy, A.I. and Yi-qiu, T., 2009. Effect of polyethylene on life of flexible pavements. *Construction and Building Materials*, 23(3), pp.1456-1464.
- [3] Adhikari, B. et. Al. (2000). Reclamation and recycling of waste rubber. *Progress in polymer science*, 25(7), pp.909-948.
- [4] Anil K Yadav, Syeed Aqeel Ahmad., 2019. A critical review of Characterization and performance Evaluation of reclaimed asphalt Pavement (rap) in road construction, *International Journal of Civil Engineering and Technology (IJCIET)*, Volume 10, Issue 01, January 2019, pp. 1379-1389.
- [5] Aravind, K. and Das, A., 2007. Pavement design with central plant hot-mix recycled asphalt mixes. *Construction and Building Materials*, 21(5), pp.928-936.
- [6] Brajesh Mishra, "A Study on Use of Reclaimed Asphalt Pavement (Rap) Materials in Flexible Pavements" 2015, vol. 4.
- [7] Dharmesh Kumar, Dr. R.K Pandey, "A Reappraisal Paper on Reclaimed Asphalt Pavement (Rap)" 2016, 487-488.
- [8] Edward J. Hoppe, D. Stephen Lane, G. Michael, Sameer Shetty, "Feasibility of Reclaimed Asphalt Pavement (Rap) Use as Road Base and Subbase Material" 2014, 15-R6.
- [9] Sonmez, A. Topcu, S. A. Yildirim, B. K. Eren, E. Gunay, M. Kara, B.Kavakli, "Recycling and reuse of old asphalt coatings in hot bituminous mixtures," in 24th World Road Congress, 2011.
- [10] Jaspreet Singh, Jashanjot Singh, A.K Duggal, "A Review Paper on Reclaimed Asphalt Pavement (Rap)" 2015.
- [11] Khushbu M. Vyas, Shruti B. Khara, "Technical Viability of Using Reclaimed Asphalt Pavement in Ahmedabad Brts Corridor for Base Course".
- [12] K. R. Hansen, A. Copeland, Annual Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage, 2009-2012.