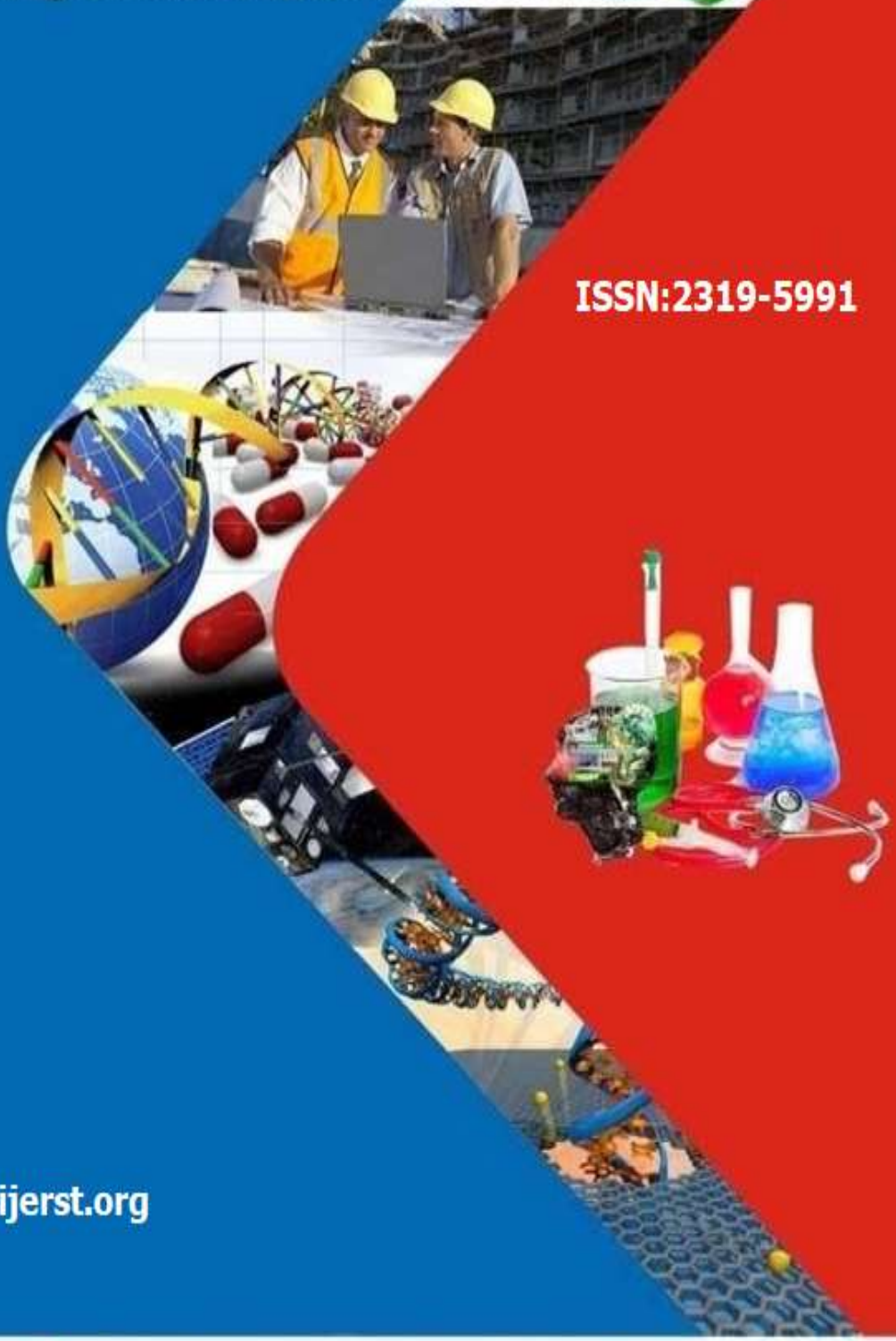
International Journal of Engineering Research and Science & Technology

IJERST



ISSN:2319-5991

www.ijerst.org

E-mail: editor@ijerst.org or ijerst.editor@gmail.com

ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 2, 2025

RECYCLING OF FLEXIBLE PAVEMENT

[1] Anil Babu Gogineni,[2] Dr.K.Sreekar Chand
[1]Student,[2] Associate Professor & Hod Of Civil Department
Department Of Civil Engineering
AM REDDY MEMORIAL COLLEGE OF ENGINEERING AND TECHNOLOGY,
Petlurivaripalem,Andhra Pradesh

ABSTRACT:
One of the most crucial parts of any project's design is the pavement. The part of the road that stands out most to drivers is the pavement. The degree to which the pavement is smooth or coarse is often used as a measure of the highway's condition and sufficiency. Poor pavement conditions may raise the likelihood of accidents, increase fuel consumption and brake forces, and lengthen travel times and associated expenses for users. The durability and longevity of the pavement are directly proportional to the material's strength and stiffness. Therefore, while designing pavement, it is important to prioritize the most cost-effective and efficient use of existing materials in order to maximize their performance. It is necessary to restore the roadways using environmentally friendly approaches in order to improve them for future generations, since the deteriorated pavements are left unmanaged. It is possible to create rehabilitation methods by researching different kinds of distresses, material circumstances, and environmental factors. Finding damaged pavement and creating a repair method using RAP material to enhance the road's fatigue life economically are the main topics of this research. The development and upgrading of existing asphalt roads, such as Major District Roads (M.D.R.), State Highways (S.H.), and National Highways (N.H.), produces reclaimed asphalt pavement (R.A.P.), the most prevalent industrial waste. The study begins with an overview of the topic and then moves on to a literature review, testing methodologies, bituminous mixture mix design, and finally, the design of flexible pavements. In order to increase strength while decreasing cost, the granular and bituminous layers employ 30% RAP.

Important terms: Reclaimed Asphalt Pavement, Major District Roads, State Highways, and National Highways.

I. INTRODUCTION

1.1 Problem Description

The significance of pavements and their upkeep has been growing fast in recent times as a result of industrialization and globalization. However, the resources are not sustainable, therefore the growing demand has not been efficiently matched by the available supply. The "Ministry of Road Transport and Highways" (MORTH) is the umbrella organization in India responsible for overseeing the country's road network. Many consider India's road system to be second in size only to America's. However, the state of the roads is one of the shocking realities. For the last three decades, this has been true.

Lack of oversight led to subpar construction quality with the majority of the roads being single-lane designs. Over the last two decades, there has been a dramatic rise in the amount of traffic on the main road system, which has caused highway pavements to break faster than anticipated. It is necessary to restore the roadways using environmentally friendly approaches in order to improve them for future generations, since the deteriorated pavements are left unmanaged. It is possible to create rehabilitation methods by researching different kinds of distresses, material circumstances, and environmental factors.

Reusing aggregates and bitumen is the only option for recycling current bituminous mixtures. Pavement restoration is an economical and sensible strategy to preserve our current pavement network while also protecting our dwindling supply of building materials.

ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 2, 2025

An in-depth analysis of the current pavement structure's condition, its performance history, and the materials' appropriateness for use in the rehabilitation design is often necessary when developing a rehabilitation design. Finding a cost-effective way to repair ancient pavements relies heavily on evaluating the residual strength of the various layers, including subgrade, that make up the pavement in its current condition. Recycled asphalt paving materials, such as Recycling Asphalt Pavements (RAP), are being investigated for use in the project.

Using RAP material in the granular layers as DBM, BC, and WMM is the focus of the research. The materials themselves are recovered asphalt. When compared to before stabilization, the pavement's characteristics and strength are improved. Additionally, it increases the pavement's durability and fatigue life.

Study Significance (1.1.1)
In response to rising traffic, the National Highway Authority of India (NHAI) is transforming a number of State Highways (SH) and Major District Roads (MDR) into National Highways (NH). Following the standards of the period, the majority of these roads were first constructed as carriageways with only one lane. Lack of oversight also contributed to poor building quality. These roads were enlarged to intermediate/two-lane carriageways in the later era and reinforced periodically with asphalt overlays to meet traffic demands. So, the top asphalt layers have thickened due to periodic strengthening, making the below boundless layers physically and functionally unable to support the growing traffic loads. Utilizing RAP in the granular levels to strengthen the bottom layers becomes crucial. The development and upgrading of existing asphalt roads, such as Major District Roads (M.D.R.), State Highways (S.H.), and National Highways (N.H.), produces reclaimed asphalt pavement (R.A.P.), the most prevalent industrial waste. The nation is wasting millions of tons of asphalt that might be used for new pavements and road repair projects if only it were treated and recycled correctly. An important step in reducing our impact on the environment is the recycling of asphalt pavements. Because it uses less energy, it is a sustainable solution. Thus, RAP has many beneficial consequences; but, Indians are notoriously slow to adopt new technology. There has been very little development in the asphalt pavement recycling industry. Significant material, financial, and energy savings may be achieved by the recycling of asphalt pavement materials to create new pavement materials. Here are a few key points about the advantages of recycling:

• Significant cost savings when compared to using new materials; • Significant energy savings when compared to traditional building methods; • Performance on par with or better than new materials; • Preservation of pavement geometry; and • Conservation of natural resources.

II. REVIEW OF LITERATURE

2.1 Introduction

In this section, we will go over the research articles that were evaluated in order to accomplish the project's goal. The use of RAP material in pavement courses is a topic that is currently being investigation. Using RAP and its characteristics in pavements was the subject of the publications. They included a number of methods into this idea. There was some variation in the ways that RAP was used in the studies, either as a base material or mixed with virgin bitumen and aggregate. Depending on the specific topic covered, the collected literature articles are categorized into several sets. Here is how it is categorized:
Use of RAP in Bituminous Layers, Flexible Pavements, and Other Applications

According to estimates made in the early 1990s by the Federal Highway Administration and the United States Environmental Protection Agency, the annual reclamation of asphalt pavement exceeded 90 million tons, with over 80% of RAP being recycled. This made asphalt the material that was recycled most often. Granular base or subbase, stabilized base aggregate, embankment or fill material, and virgin asphalt binder are some of the most typical uses for RAP, but it is also used as an aggregate and a binder for

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com

Vol. 21, Issue 2, 2025

asphalt. Raw aggregate pulverized (RAP) is an excellent alternative to virgin aggregates and binders, which are more costly.

Laboratory testing of RAP and RAP-virgin aggregate mixes for use as Oman road bases and subbases was conducted by Taha et al. (1999). Based on the literature review, it was found that recycled aggregates can be used in base courses with new or virgin aggregates up to a percentage of 10 to 100% RAP. Additionally, stabilizing materials such as lime, cement, foamed bitumen, fly ash, RBI Grade-81, etc., can increase the mix's strength and durability (Taha et al., 1999, 2002, Thammavong et al., 2006). Evaluate RBI Grade-81 stabilization in the base layer to see whether it is suitable The use of RBI Grade-81 stabilizers for subgrade and base layer was investigated by Kumar et al. (2010), who concluded that the stabilized aggregate layer is an appropriate choice for the base layer. Due to rising demand and dwindling supplies of aggregate and binder, manufacturers of Hot Mix Asphalt (HMA) have started incorporating recovered asphalt pavement (RAP) into their product. The employment of more RAP in HMA has so recently attracted fresh attention. About 70% of the total cost to manufacture HMA goes toward materials, making them the most costly component of manufacturing costs. Among asphalt ingredients, the asphalt binder is both the most costly and economically variable. Layers of flexible pavement often include it because of its tensile strength, which helps to resist deformation, shields the asphalt pavement structure and subgrade from water, and creates a surface that is smooth and resistant to skidding. Therefore, RAP is most cost-effective when used in the surface and intermediate layers of flexible pavements, where its cheaper binder may partially substitute the more costly virgin binder.

III. OBJECTIVE AND METHODOLOGY

Aim

Finding damaged pavement and creating a repair method using RAP material to extend the road's fatigue life economically are the primary goals of the project. It is possible to assess the granular and surface layers of reclaimed asphalt pavement for their potential usage.

3.2.1 Goal

• Analyze the present state of the art in employing RAP in flexible pavement surface and base courses by reviewing research findings on the material.
For the purpose of researching aggregate, rap aggregates, rap bitumen, and bitumen's characteristics.
• To determine the ideal amount of binder to use in the DBM/BC mixture.
• Determine the ideal ratio of cement, stone dust, SCBA, and brick dust to other fillers for use in DBM and BC mixtures.
• To compare the bituminous mix's performance with and without RAP.

3.3.3 Approach

In order to accomplish this goal, the following technique is used:
Locating the pavement that needs repair is the first stage. The chosen project corridor is situated in the Indian state of Telangana and extends from Rotary Nagar (NH 365BB) to Dhanavaigudem Railway Bridge, Raparthi Nagar, Khammam, as well as the Railway Over Bridge. The road's chainage extends for 5.4 kilometers. Finding the locations and conditions of the damaged pavement is the next stage after choosing it. At three (3) regular intervals along the route, bituminous samples are collected. The project's following phases are divided into five components as shown in the flow diagram.

PART - I

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com

Vol. 21, Issue 2, 2025

IV. ANALYSIS OF RESULTS

Optimum binder content

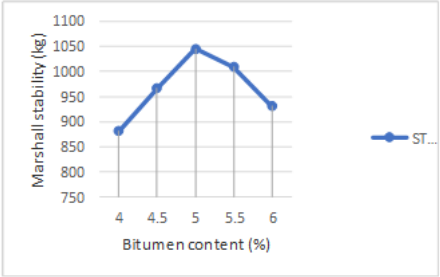


Figure : Optimum binder content determination graphs for BC (Stability)

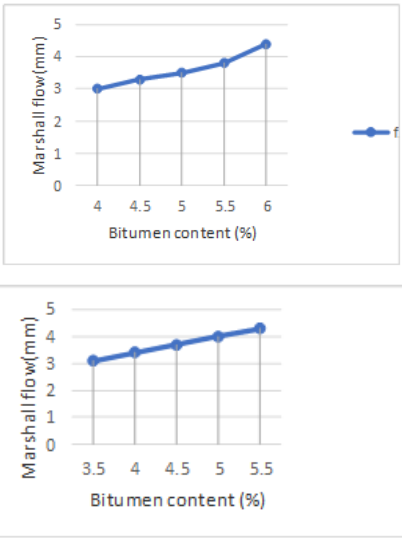


Figure 5.4: Optimum binder content determination graphs for DBM (flow)

From the graph 5.3 and 5.4, it clearly knowns that the optimum binder content for DBM mixes is 4.5%.

Optimum filler content with various different types of fillers

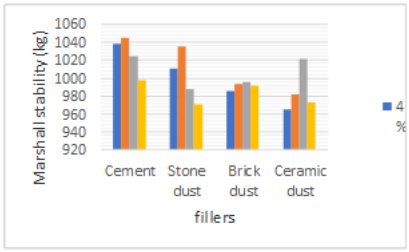


Figure: Optimum filler content determination graphs for BC (Stability)

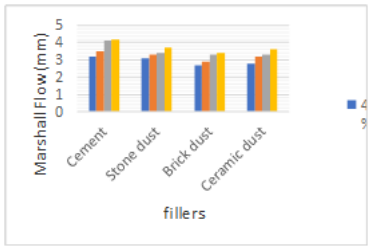


Figure : Optimum binder content determination graphs for BC (flow)

The Ascending order of marshall stability with respect to the filler and its percentage : 996kg (Brick dust 6%) < 1021kg (SCBA 6%) < 1035kg (stone dust 5%) < 1079kg (cement 5%).

SUMMARY AND CONCLUSIONS

SUMMARY

The goal of this project was to find out how well road bases and wearing courses made from recycled asphalt pavement (RAP) worked. Research into recycled asphalt pavement (RAP) and its potential use in the wearing course and granular layer as a WMM or BC-DBM is central to this project's activities. The goals of the research could only be realized after an exhaustive literature search. The idea of RAP was better understood after reading and analyzing a number of research articles. Collecting samples and evaluating them on the spot were both part of the field research. Samples were subjected to a battery of tests in the lab to ascertain their characteristics, including: • Granular size analysis • Atterberg limits • Free swelling index • Compaction and optimum moisture content • California bearing ratio test • The collected RAP material was examined for its binder content, gradation, and properties.

• The Bituminous Design Mix was completed by using the Marshall Stability test, also known as the MS 2 Mix design procedure, after the analysis of the parameters. Here, four distinct filler materials—cement, stone dust, brick dust, and ceramic powder—are compared. The Marshall Stability of Cement mix is higher than that of the stone dust mix, the brick dust mix, and the SCBA when compared to Ceramic Waste, Brick Dust Cement, and Stone Dust, respectively. The stability value of a ceramic mix is low compared to that of a cement

ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 2, 2025

mix. All of the mineral filler requirements for the MORTH bituminous concrete mixture may be met by using ceramic waste.
• This method involves mixing 30% RAP bitumen with varying amounts of varying RAP aggregates (ranging from 0% to 50%) in a DBM and BC mixture. A 30% RAP concentration is optimal for stability.
The CBR test is performed on the mixture that contains 30% RAP in the WMM. The CBR value of WMM need to be at least 85% in order to comply with MORTH restrictions. The RAP allowed for a 91% CBR to be achieved.

Final Thoughts
• The primary goal was to restore the aged pavements by incorporating RAP into the granular and bituminous layers.
• The use of RAP in the mixture improved the pavement's strength at lower bitumen concentration, which in turn reduced the pavement's cost.
• One possible solution to the major disposal issue and a step toward environmental salvation is to use ceramic industrial waste in lieu of traditional mineral fillers in bituminous mixtures.
• RAP, an environmentally harmful substance that has high strength compared to other mixes, is used 30% as a substitute for bitumen and aggregates.
• The use of RAP material, an environmentally harmful substance, to replace 30% of the granular layer. Harmful gasses evolve from the dumping of old bituminous mix in open environment.
This technology will improve the use of RAP in environmentally friendly pavement rehabilitation.
• The granular layers, or base, are now stronger. The CBR value of the WMM mixture may be used to sort this.
Milling the RAP, which is a freely accessible resource, results in a relatively inexpensive procedure. It is possible to reduce the amount of fresh bitumen and aggregates used in new pavements using this restoration method.
For cost-effective pavement restoration solutions to work, the pavement's current state and the qualities of the materials used are the most important elements.
In addition to being environmentally friendly and providing cost-effective options, pavement rehabilitation techniques such as rebuilding utilizing deconstructed asphalt materials will guarantee the required performance level for the whole pavement's design life at the stipulated cost.

Implications for the Future
Rehabilitating pavements with the proper percentage of RAP in the granular and bituminous layers achieves the purpose of the current research. I thought of using RAP in the bituminous and granular layers, but the study might be expanded to include stabilizing RAP in the subbase and subgrade layers as well. As a result, RAP's qualities could be improved even further.
This project looked at a 30% utilization in DBM, 30% in BC, and 30% in the WMM combination. These percentages may be adjusted according to what's available and what's needed. The stability of RAP at different amounts, however, is something we cannot guarantee. Alternately, it may go down. While most Indian highways are typically designed using conventional asphalt overlay rehabilitation schemes, it is important to compare different rehabilitation options that take into account the current pavement condition and residual strength of the existing pavement layers in order to find the best solution in terms of performance and cost.

REFERENCES

[1] Ishraq Hameed Naser (2021) “A review of RAP and its use in pavement engineering” Global Journal of Engineering and Technology Advances, 2021, 07(01), 073–084.
[2] B A V Ram Kumar (2021) “Sustainable materials in the production of pavement base and subbase courses” July 2021- IOP Conf. Ser.: Mater. Sci. Eng. 1025 012013.
[3] Farag Khodary (2021) “The Effects of Adding Reclaimed Asphalt Pavement (Rap) And Cement on The Properties of Pavement Base Course” [IJIERT] ISSN: 2394-3696 Website: ijiert.org Volume 8, Issue 4, Apr.-2021.

ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 2, 2025

[4] Priyanka Parashar (2020) "Utilization of Reclaimed Asphalt Pavement Materials in Rigid Pavement" International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181 IJERTV9IS060149 (This work is licensed under a Creative Commons Attribution 4.0 International License.) Published by: www.ijert.org Vol. 9 Issue 06, June-2020.

[5] Syed Aqeel Ahmad (2020) "Characterization of Classified Indian Reclaimed Asphalt Pavement (RAP): In-Situ and Lab Density, Bitumen Content and Gradation Characteristics" International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-5, January 2020.

[6] Elvis S.K. Mensahn (2020) "Flexible Pavement: A Review on the Influence of Waste Rubber Particles in Asphalt and Asphalt Mixtures" e-ISSN: 2395-0056 Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072.

[7] Ranjitham Mariyappan (2020) et al "Consideration of Strength Parameters of Reclaimed Asphalt Pavement (RAP) Concrete over Conventional Concrete" Ranjitham Mariyappan et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 955 012053.

[8] Anil Kumar Yadava (2020) "Characterization of Classified Indian Reclaimed Asphalt Pavement (RAP): Aggregate Impact Value and Aggregate Abrasion Value of Rap Aggregates" International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-9 Issue-3, February, 2020.

[9] Ahmed Arqam Ruknuddin (2019) "Stabilization of Subgrade Soil using Reclaimed Asphalt Pavement (RAP)" International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958, Volume-8 Issue-5, June 2019.

[10] R.B.Ahmed (2018) "Recycling Of Reclaimed Bituminous Pavement Materials" 1st International Conference on Research and Innovation in Civil Engineering (ICRICE 2018), 12 –13 January, 2018, Southern University Bangladesh (SUB), Chittagong, Bangladesh.

[11] Yomiyu Reta (2018) "Experimental study on the use of reclaimed asphalt pavement as base course materials through blending with crushed stone aggregates" wjert, 2018, Vol. 4, Issue 2, 126-167.

[12] N. A. MEMON (2016) "Rigid Pavement Design Using Recycled Asphaltic Materials" Sindh Univ. Res. Jour. (Sci. Ser.) Vol. 48 (2) 399-406 (2016).

[13] Brajesh Mishra (2015) " A Study on Use of Reclaimed Asphalt Pavement (RAP) Materials in Flexible Pavements" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 4, Issue 12, December 2015.

[14] T.Anil Pradyumna (2014) "Use of RAP Stabilized by Hot Mix Recycling Agents in Bituminous Road Construction" Transportation Research Procedia 17 (2016) 460 – 467.

[15] H. Ayyanna, M.S. Amarnath and G.L. Sivakumar Babu "Laboratory Investigations on Stabilized Reclaimed Asphalt Pavement(RAP) material", Indian Highways, July 2015

[16] Quality Base Material Produced Using Full Depth Reclamation on Existing Asphalt Pavement Structure", FHWA Report No. FHWA-HIF-12-015.

[17] Deren Yuan,Soheil Nazarian, Laureano R. Hoyos, Anand J. Puppala ,"Evaluation and Mix Design of Cement-Treated Base Materials with High RAP Content", Paper Number, 2011; 11-2742, Annual TRB Meeting.

[18] Ramzi Taha, Galalali, Adnan Basma, and Omar Al-Turk, "Evaluation of Reclaimed Asphalt Pavement Aggregate in Road Bases and Sub- bases", Transportation Research Record 1652, 1999, 264-269.

[19] Satander Kumar and Anukul Saxena, "Soil and Aggregate Stabilization for Sustainable Pavement"New Building Material and Construction World, December 2010.

[20] Pranshoo Solanki, Musharraf M. Zaman, and Jeff Dean "Resilient Modulus of Clay Sub grades Stabilized With Lime, Class C Fly Ash, and Cement Kiln Dust for Pavement Design" TRB, Washington D.C, 2010; No. 2186, 101–107.

[21] Ministry Of Road Transport and Highways, Specifications for Road and Bridge Works, Section-400,Sub-bases,Bases(Non-Bituminous) and shoulders.

ISSN 2319-5991 www.ijerst.com
Vol. 21, Issue 2, 2025

[22] Ramzi Taha, Ali Al-Harthy, Khalid Al'Shamsi, and Muamer Al-Zubeidi. "Cement Stabilization of Reclaimed Asphalt Pavement Aggregate for Road Bases and Subbases", Journal of Materials in Civil Engineering, ASCE, 2002; 14: No. 239.

[23] Anouksak Thammavong and Prof. Dr. Direk Lavansiri. "Cement Stabilization of Reclaimed Asphalt Pavement Aggregate for Base Layer", Technology and Innovation for Sustainable Development Conference, Thailand, January 2006.

[24] Abhishek Verma, Rachit Sharma, Monil Shrivastava and Prashanth (2017) " EVALUATION OF RECLAIMED ASPHALT PAVEMENT (RAP) IN FLEXIBLE PAVEMENT LAYERS" WJERT , 2017, Vol. 3, Issue 2, 91 -104.