iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 10 **Issue:** IV **Month of publication:** April 2022

**DOI:** https://doi.org/10.22214/ijraset.2022.42031

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 10 Issue IV Apr 2022- Available at www.ijraset.com*

# Study of Effective Utilization of Waste P.E.T (Plastic) and Steel Slag to Enhance the Performance of Bitumen Based Pavement

Anjali Hasban[1], Ashish Waje[2], Vaishnavi Vhatte[3], Samruddhi Shinde[4], R.A. Binayake[5]
[1, 2, 3, 4, 5]*Department of Civil Engineering, JSPM's ICOER Wagholi, Pune*

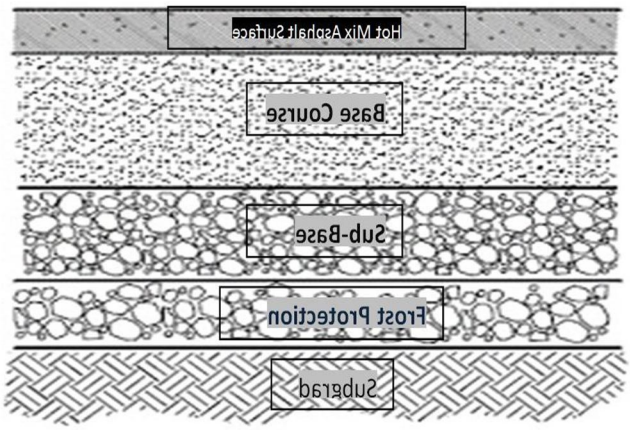
***Abstract:*** ***The present work was carried out to propose the use of processed waste plastic (P.E.T) and steel slag aggregate (SSA) for the modification of bituminous mix in order to cater the need of the enhancing the performance of flexible pavements as well as to minimize the quantum plastic waste in society as they have been posing a serious threat to environment. There are two methods available namely wet and dry process of incorporating waste plastics into bituminous mixes. Research work has been carried out by adopting the wet process. In this study, wet process is carried out on the grade1 suggested by MoRTH and IRC for BC mixes. The Marshall method of mix design was adopted using Penetration grade 60/70 binder to find the optimum binder content for all conventional as well as modified bituminous mixes and to find out optimum plastic and steel slag content that can replace these conventional materials. Marshall Specimens were prepared at bitumen contents of 4.0, 4.5, 5.0% by weight to find optimum bitumen content, with P.E.T content of 0%, 4%, 6%, 8%, 10% by weight of bitumen and with steel slag aggregate content of 5%, 10% and 15% to find out respective limits and their properties. Marshall Stability, Flow value, Marshall Quotient, Air voids (Vv), Voids in Mineral Aggregates (VMA), Voids Filled with Bitumen (VFB), Retained Stability, were determined by adopting the wet process and compared with neat BC mixes. From the test results, it is clear that the Marshall Test values for modified mixes was much higher as compared to conventional bituminous mixes.***

***Keywords: Bitumen, Aggregate, P.E.T (Polyethylene Terephthalate), Steel slag.***

## I. INTRODUCTION

This project work includes the performance and fatigue behavioral study of Bituminous Mix. Bituminous Mix is mixture of coarse aggregate, fine aggregate, bitumen, and filler material. The guidelines regarding Bituminous mix are given in IRC: 29-1988 Specification for Bituminous Mix (Asphaltic Mix) for road pavement and Ministry of Road Transport and Highway Authority in India, 2001 (MoRTH). All work done in this project is according to the guidelines laid in IRC and MoRTH. Bituminous concrete mix is used in wearing course of flexible pavement. Bituminous binders are widely used by paving industry. Generally, all the hard surfaced pavement types are categorized into stability analysis is essentially a problem of optimization namely the determination of the slip surface that yields minimum factor of safety 2 groups:

*1)* Flexible Pavement
*2)* Rigid Pavement



## II. LITERATURE REVIEW

1) *R. Vasudevan (2012):* Suggested use of plastics in the melted form to be used in the road construction along with the aggregates. The modified aggregates referred as polymer coated aggregates. Plastics having melting point at 110° can be coated over stone aggregates to show better performance and good durability.
2) *V.C. Renge (2012):* Reviewed that the quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in lifestyle which leading widespread littering on the landscape. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics for road mix. In the present paper developed techniques to use plastic waste for construction of flexible pavements has been reviewed.
3) *Mushtaq Ahmad (2015):* Reviewed that examines properties of waste plastic water bottles, polyethylene terephthalate (PET). The waste polymer was added to the normal bitumen penetration grade (80/100) prepared Marshall Samples using ACW-14 to investigate Marshall Parameters of polymer modified bitumen and compare with conventional bitumen. Thermal analysis of PET waste polymer was carried out using TGA and DSC to study decomposition and melting temperature of the waste polymer and select suitable type of polymer because compatibility of the material is an essential. Study justified with the past Marshall Stability of the bitumen increase 50-60% by addition of waste polymer, study findings shows that by addition of 9.0% highest Marshall Stability in mix was achieved and likewise, stiffness, flow and voids filled with bitumen properties of the Marshall Mix was improved Percentage of the void total mix found to decrease while increasing modified bitumen contents in the Marshall Mix.
4) *Bhageerathy K. P (2014):* Stated that the main objective of the study was to investigate the performance of the bituminous mix modified with bio-medical plastic waste and to compare it with the normal mix. Medical plastic waste was collected from IMAGE (Indian Medical Association Goes Eco-friendly), Palakkad, Kerala, India. As part of the study, the properties of Plastic-Coated Aggregates (PCA) were determined. The results showed improved properties for PCA when compared to normal aggregates.
5) *Johnson Kwabena Appiah (2017):* Discussed on the two main problems faced in Ghana; Firstly, management of municipal solid waste in regards with plastic; Secondly, the formation of the potholes on pavements in Ghana. He examined the effect of blending waste thermoplastics namely Low-Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE) in conventional AC-20 graded bitumen.
6) *Sudha.P (2017):* Performed the experimental inspection to evaluate the characteristics of concrete using the steel slag as a coarse aggregate. Concrete is most used material than any other material in the world, so the use of concrete is necessary at the same time which leads to the scarcity of aggregate is also increased now a day. The industrial waste has been encouraged in construction industries because it reduces the usage of natural resources. Fly ash, silica fume and steel slag were considered as a common industrial waste material. These materials are successfully used in construction industries for the partial and full replacement in concrete. In this study of M20 grades of concrete with W/C ratio 0.45 respectively for the partial replacement of coarse aggregate 20%,40%,60%,80% and 100% by steel slag.
7) *Ravi Kumar (2016):* Carried out experimental investigation to evaluate the effects of concrete by replacing the normal coarse aggregate by steel slag on properties of concrete. Concrete is used, more than any other material in the world so the use of concrete is unavoidable at the same time scarcity of aggregate is also increased nowadays. The industrial waste has been encouraged in construction industries because it contributes to reduce the usage of natural resources for many years by product such as fly ash, silica fume and steel slag were considered as waste materials. They have been successfully used in the construction industry for the partial and full substitution in concrete. In this study concrete of M20, M30, M40, M50 grades were considered for a W/C ratio of 0.55, 0.45 ,0.37, 0.32 respectively for the replacement of coarse aggregate 30% 60% and 100% by steel slag. This study revealed that there is improvement in compressive strength 5 to 10% for all the grades of concrete. There is 4 to 8% increase in split tensile strength in all grades of concrete. The Flexural strength of concrete is increase about 2 to 6% for all the grades steel slag can be use up to 60% replacement in all grades of concrete. Full replacement by steel slag decreases the strength considerably.

## III. MATERIALS

The basic materials used in construction of any flexible pavements are as follows1. Stone Aggregates of varying sizes. (6mm,10mm,12mm,20mm etc.) 2. Bitumen (VG-30 grade in Maharashtra) 3. Mineral Filler The materials which are to be added to above materials to replace them to a limited extent to enhance properties are4. Waste P.E.T plastic. (processed) 5. Steel Slag of a particular form. (Chips or having aggregate like structure)

*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 10 Issue IV Apr 2022- Available at www.ijraset.com*

FIG. BITUMEN

The above Fig shows the bitumen of grade VG-30 which was used as per the suitability for Maharashtra state. Bitumen is the main binder element, and its function is to hold the ingredients together. In above figure heating of bitumen is shown, for achieving its temperature and making it viscous/soft for further use and to analyses periods of increased/decreased landslide active.

FIG. SHREDDED PLASTIC

The above Fig shows the waste P.E.T plastic. P.E.T stands for Polyethylene Terephthalate, in simple manner it is nothing but the plastic from which plastic bottles for storing water, detergents, phenyl etc. is made. The waste form of such plastic is collected from Municipal Plants and after several processes like cleaning, drying, shredding, and cutting it is used as a modifier to bitumen or to replace bitumen content up to certain extent. It is also a binding element.

FIG. STEEL SLAG (SHOTS)

The above Fig shows the steel slag of a particular form having aggregate like structure or a chip form. This type of steel slag is incorporated as a replacement to a conventional stone aggregates up to a certain limit to enhance properties like bearing capacity etc.

## IV. METHODOLOGY

*1)* Preparation of raw material so Collection of Waste P.E.T plastic from scrap center/ Municipal solid waste dumping site.

*a)* Cleaning of plastic.

*b)* Shredding and cutting into fine pieces.

*c)* Collection of bitumen, stone aggregates, and steel slag from the supplier.

*2)* Ingredient Testing and characterization of steel slag used

Following tests were carried out on ingredient materials before their use:

*a)* *Tests on Aggregates.*

- Sieve Analysis
- Aggregate Impact Value
- Aggregate Crushing Value
- Water Absorption Test

*b)* *Tests on Bitumen.*

- Penetration Test
- Softening Point Test
- Ductility Test
- Flash and Fire Point Test
- Specific Gravity Test

*c)* *Test on Plastic.*

- Softening Point of P.E.T plastic
- Binding Property

*d)* *Tests on Steel Slag*

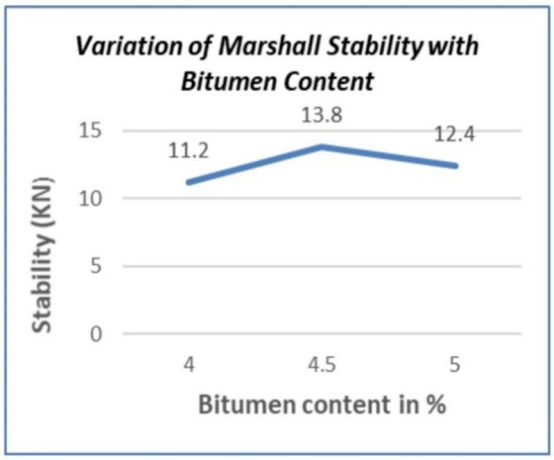
- Impact value of steel slag
- Specific Gravity of steel slag
- Study about its chemical composition

*e)* *Test on Conventional and Modified molds*

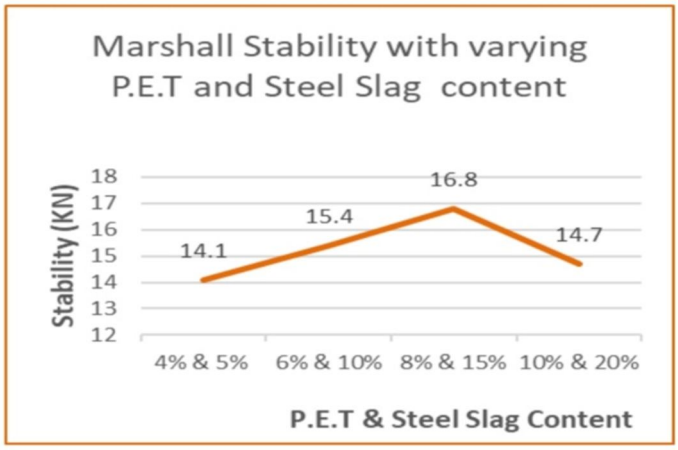
- Marshall Stability
- Marshall Flow

## V. RESULTS

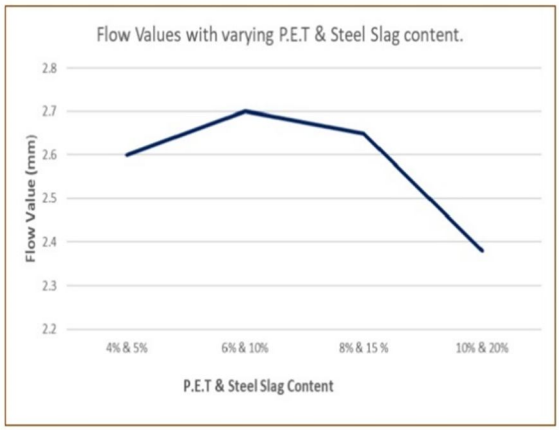
| Sr.no. | properties | 4and5% | 6and10% | 8and15% | 10and20% |
|---|---|---|---|---|---|
| 1 | Marshall stability in KN | 14.1 | 15.4 | 16.8 | 14.7 |
| 2 | Flow value mm | 2.6 | 2.7 | 2.5 | 2.38 |
| 3 | Average height of specimen | 6.8 | 6.8 | 6.8 | 6.8 |
| 4 | Weight of specimen in air | 1258 | 1260 | 1259 | 1263 |



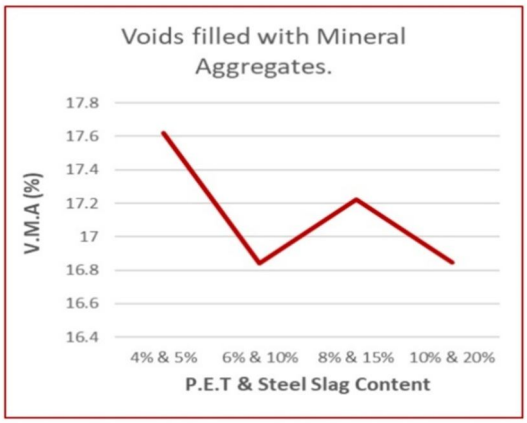

The graph in above Fig shows the variation of Marshall Stability for varying bitumen content. From above the Optimum Bitumen Content for conventional mix was found out. It is the content of bitumen in percentage for which maximum stability is achieved.



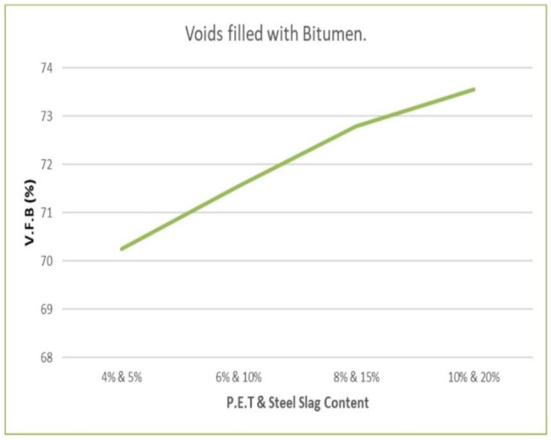

The above Fig shows the Marshall Stability values in KN for various P.E.T and steel slag combinations. For example- 4% P.E.T as a replacement to bitumen and 8% steel slag as a replacement to aggregates by total weights.




The above Fig shows the Marshall Flow values in mm for various P.E.T and steel slag combinations. It is observed that result starts falling(negative) after point of 8% P.E.T and 15% steel slag addition. IRC specification for Marshall Flow ranges between 2mm-5mm.




The above Fig shows the graph representing Voids in Mineral Aggregates (VMA) in percentages.



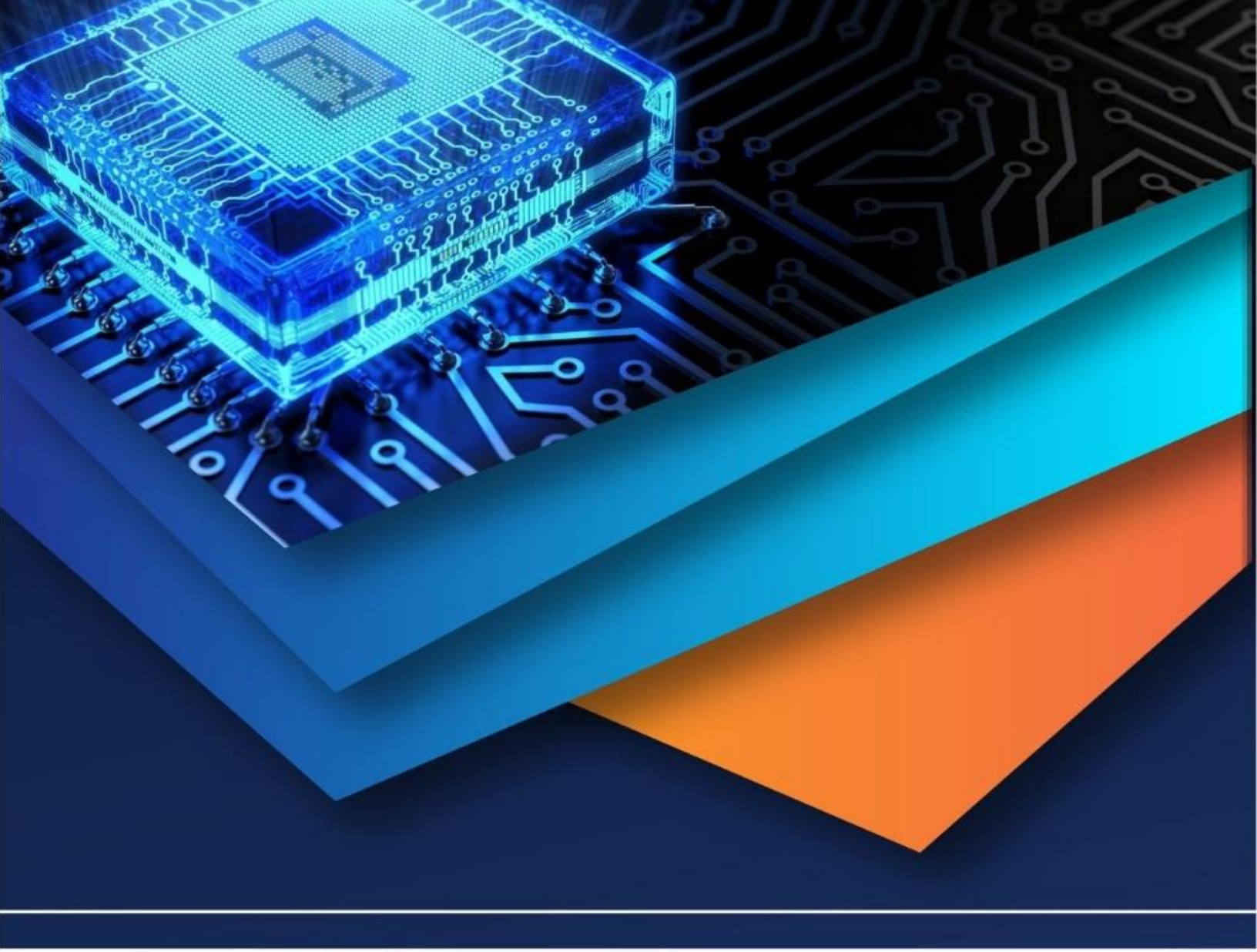

The above Fig shows the graph representing Voids Filled with Bitumen (VBF) in percentages

## VI. CONCLUSIONS

The optimum bitumen content was found out to be 4.5% It is seen that up to 8% use of plastic and 15% of steel slag improved results can be achieved. The overall cost of laying the road of approximately 3.75m can be cut down up to Rs.36000/- per kilometer by implementation of plastics in road construction. This is because around one ton of bitumen is saved which costs for around Rs.35000- 37000 (Dr. R Vasudevan).

## REFERENCES

[1] R. Vasudevan.” A Technique to Dispose Plastics in an Eco-friendly Way- Application in Construction of Flexible Pavements”, Construction and Building Materials 28(2012) 311- 320; 20 October 2011.
[2] Bhageerathy K. P, Anu P. Alex, Manju V. S, Raji A. K (2014), “Use of Biomedical Plastic Waste in Bituminous Road Construction”. International Journal of Engineering and Advanced Technology (IJEAT). ISSN: 2249 – 8958.
[3] Mrs. Vidula Swami, Abhijeet Jirge, Karan Patil, Suhas Patil, Sushil Patil, Karan Salokhe, “Use of waste plastic in construction of bituminous road”. International Journal of Engineering Science and Technology (IJEST).
[4] Mushtaq Ahmad, Mohamad Bin Ayob (2015), “Improvement of Asphaltic Concrete by Using Waste Polyethylen Terephthalate (PET)”. International Journal of Innovative Research in Science, Engineering and Technology. Volume-4 Issue-8.
[5] Srinivasa Raju Penmetsa, Ashwin Kesiraju, Addepalli Dinesh Varma (2015), “Productive Re-Use of Municipal Plastic Waste to Improve Temperature Resistance and Reduce RainWater Infiltration in Flexible Pavement”. International Journal of Civil Engineering and Technology (IJCET). Volume-6 Issue-3.
[6] Johnson Kwabena Appiah.” Use of Plastic Waste for Road Construction in Ghana”, Case Studies in Construction Materials 6(2017).
[7] S.P, Hadadi1, Lakshmi Medleri, Shilpa Nayak, “Characteristic Strength of Concrete using Steel Slag as a Coarse Aggregate”. International Journal of Engineering Science and Computing (IJESC); 2017.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY