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IMPROVEMENT IN CHARECTERISTICS OF POROUS ASPHALT USING CRUMB RUBBER

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ABSTRACT

The purpose of this study is to investigate the effect of size distribution and concentration of crumb rubber on the performance characteristics of porous asphalt mixture. The recycling of scrap tires in asphalt pavements appears as an important alternative providing a large-scale market. The characteristics of bitumen are very important with regard to service life of porous asphalt pavement. The experimental study consists of two main steps. Firstly, the mixture design was performed to determine the optimum bitumen content. In the latter step, the mixtures were modified by dry process using crumb rubber in three different grain size distributions of #4~#20, #20~#200, and #4~#200 and rubber content of 30%, 40%, and 50% of bitumen. The permeability, Cantabro abrasion loss, indirect tensile strength, moisture susceptibility, and resilient modulus tests were carried out on the specimens. Test results show that #20~#200 sized rubber particles reduced air voids and coefficient of permeability, while they increased the Cantabro abrasion loss. In general, increasing the crumb rubber size and content decreased the performance characteristics of the porous asphalt mixtures.

I. INTRODUCTION

Concept of Porous Pavements

Pervious paving systems are paved areas that produce less storm water runoff than areas paved with conventional paving. The reduction in storm water runoff is achieved primarily through the infiltration of a greater portion of the rain falling on the area than would occur with conventional paving. This increased infiltration occurs either through the paving material itself or through void spaces between individual paving blocks known as pavers.

porous paving systems consist of a porous asphalt or concrete surface course placed over a bed of uniformly graded broken stone. The broken stone bed is placed on an uncompacted earthen subgrade and is used to temporarily store the runoff that moves vertically through the porous asphalt or concrete into the bed. The high rate of infiltration through the porous paving is achieved through the elimination of the finer aggregates that are typically used in conventional paving. The remaining aggregates are bound together with an asphalt or Portland cement binder. The lack of the finer aggregate sizes creates voids in the normally dense paving that allow runoff occurring on the paving to move vertically through the paving and into the void spaces of the broken stone storage bed below. From there, the stored runoff then infiltrates over time into the uncompacted subgrade soils similar to an Infiltration Basin. The depth of the bed, which also provides structural support to the porous surface course, depends upon the volume and rate of rainfall that the porous paving system has been designed to store and infiltrate and the void ratio of the broken stone.

Crumb Rubber

Crumb Rubber is recycled rubber from automotive and truck scrap tires. During the recycling process steel and tire cord is removed leaving tire rubber with a granular consistency. Continued processing with a granulator and/or cracker mill, possibly with the aid of cryogenics or mechanical means, reduces the size of the particles further. The particles are sized and classified based on various criteria including colour (black only or black and white). The granulate is sized by passing through a screen, the size based on a dimension (1/4") or mesh (holes per inch: 10, 20, etc.). Crumb rubber is often used in astroturf as cushioning, where it is sometimes referred to as astro-dirt.

Mesh refers to material that has been sized by passing through a screen with a given number of holes per inch. For example, 10 mesh crumb rubber has passed through a screen with 10 holes per inch resulting in rubber granulate that is slightly less than 1/10 of an inch. The exact size will depend on the size of wire used in the screen.

Fig. 1

II. OBJECTIVE

Following are the proposed objectives of the crumb rubber porous asphalt pavement

- To make the bitumen pavements porous without losing the desired strength for low traffic roads. use less amount of fine aggregate.
- To enhance the strength of porous asphalt by using crumb rubber bitumen.
- To compare the strength of conventional porous asphalt mix and crumb rubber asphalt mix.
- Storm water management.

1980s. Due to the hot weather, overloaded traffic and poor material properties, the porous asphalt pavement paved in that time is not quite successful. This paper deals with the present research, especially the material composition and its impacts on the performance of porous asphalt pavement. In this study, the empirical equation of air void versus gradation was derived from uniform experimental analysis so that the target gradation could be achieved by using the formula. In addition, the quantitative relationship between air void and drainage efficiency is obtained by a series of experimental studies, and the performances of porous asphalt mixture with three types of bitumen are evaluated to analyse the influence of asphalt property on that of the asphalt mixture. Finally, the binder requirement of porous asphalt for China's weather and traffic condition is proposed.

III. LITERATURE REVIEW

Prof. Prithvi Singh Kandhal and Sapan Mishra, "Design, Construction and Performance of Porous Asphalt Pavement for Rainwater Harvesting", Indian Road Congress Journal, "Indian Highways".

Multi-storied commercial and residential buildings, which significantly increase the demand for water supply, are increasingly being constructed in urban India. In many states of India such as Bihar, Delhi, Gujarat, Haryana, Punjab, Rajasthan and Tamilnadu, the ground water is plunging at an alarming rate. Responsible town planners, architects and civil engineers must be proactive and integrate rainwater harvesting techniques in the design of all types of buildings, parking lots and low traffic roads/streets. This would recharge the ground water in over-exploited/critical areas of India. The revolutionary technology presented in this paper addresses that very need.

Dr B V Kiran Kumar, Manjunatha S, Shiva Prasad N, " Porous asphalt pavement a tentative mix design guidelines – by new generation open graded friction course approach", "ijesird, vol.1 (3), September 2014-15".

Porous asphalt pavements are an alternative technology that differs from traditional asphalt pavement designs in that the structure permits fluids to pass freely through it, reducing or controlling the amount of run-off from the surrounding area. By allowing precipitation and run-off to flow through the structure, this pavement type functions as an additional storm water management technique accounting for ground water recharge. The overall benefits of porous asphalt pavements may include both environmental and safety benefits including improved storm water management, improved skid resistance, reduction of spray to drivers and pedestrians, as well as a potential for noise reduction.

Key words: Porous Asphalt Pavements, Permeability, Drain down potential, Ageing Potential, Cantabro Abrasion, Water Sensitivity, Marshall Stability.

Qingquan Liu and Dongwei Cao, "Research on Material Composition and Performance of Porous Asphalt Pavement", "journal of materials in civil engineering © asce / April 2009 / 135".

With many advantages such as high skid resistance, low noise, and fewer splashes and spray, porous asphalt pavement can significantly improve driving quality in wet weather condition and is used widely in Europe, the United States, and Japan. The early research in China on porous asphalt pavement was started in the

Parmar Manisha, Dr. A. M. Jain, "Feasibility of Porous Pavement: A Case Study at Hatkeshwar Area of Ahmedabad City", "2014 IJEDR | Volume 2, Issue 2 | ISSN: 2321-9939".

This study represents the experimental work related to porous pavement feasibility. Now a days porous pavement is a new concept introduced worldwide. In India and other countries research is going in positive direction. There are many advantages of porous pavement. Porous pavements allow storm water runoff to filter through surface voids into an underlying stone reservoir where it is temporarily stored and/or infiltrated. For this study Hatkeshwar area of Ahmadabad city has been selected with the specific road network nearby to the Narol-Naroda corridor link joining CTM cross road to karnavatibungalows. The above road network has the history of the accumulation of water in the area during the monsoon season for long duration. To study the above objective the rainfall data for the area during the different day, month is collected. The volume data is the other important aspect for identifying the low volume road. The quality of soil sub grade is the other data, which is collected for

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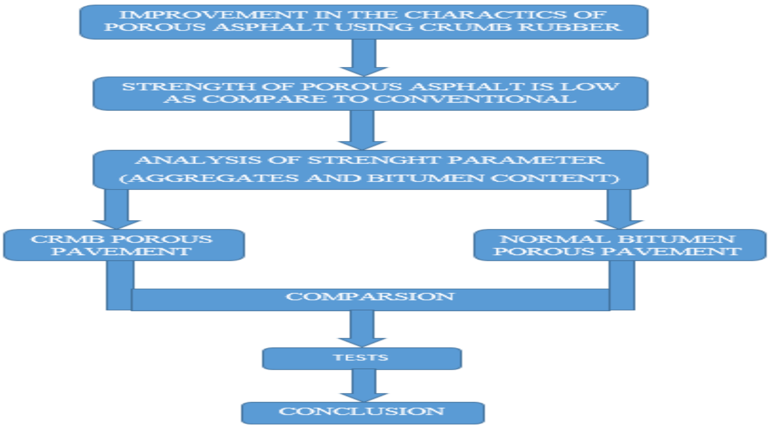
determining the thickness of porous asphalt concrete at this road network. The soil quality is also useful in order to identify suitability of disposal of the seepage ground water nearby to the stream/artificial drainage link.

IV.METHODOLOGY

Research Methodology-



- Collection of raw material.
- Detail study about collected material.
- Test on collected material.
- Preparation of model.
- Test on model

V. RESULT

Drainage value of the normal bitumen sample-6.20ml/sec

Drainage value of the crumb rubber bitumen sample-6.17ml/sec

5.1.1 Test on Aggregate

Sr. No.	Test	Result	Range
1	Crushing Value	28.66 %	Should be less than 30 %
2	Specific Gravity	2.85	2.6-2.9
3	Water Absorption	0.845	Should be greater than 0.6 %
4	Impact Value	6.14 %	Should be less than 30 %

Table 5.1.1 Tests on Aggregate

- The crushing value of aggregates is 28.66 % which is less than 30 %. So the aggregates are suitable for the surface course.
- The Specific gravity of aggregates is within the specified range. So the aggregates are suitable for the road surface.
- The water absorption of the aggregates is greater than 0.6 %. So the aggregates are suitable for the study.
- The Impact Value of aggregates is 6.14 %. This indicates that the aggregates are exceptionally strong.

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Thus, all the tests on aggregates were successful and the aggregates are best suited for the study.

5.1.2Testing On Bitumen

Sr. No.	Test	Normal Bitumen	Crumb Rubber Bitumen	Test Method
1	Penetration Test	64.43 (60-70)	41 (40-60)(30% crumb rubber) 39(40-60)(40% crumb rubber) 31.67(40-60) (50%crumb rubber)	IS 1203-1978
2	Softening Point Test	87.75° C	88.68° C(30% crumb rubber) 89.15° C(40% crumb rubber) 92.18° C(50% crumb rubber)	IS 1205-1978
3	Ductility Test	8.46 cm (min. 7.5)	1.8cm(30% crumb rubber) 1.55cm(40% crumb rubber) 1.35(50%crumb rubber) ---------	--------
4	Elastic Recovery Test	--------	8cm (min. 30)	ASTM- D596-1996
5	Stripping value test	4.19%	0	-------------------

Table 5.1.2 Tests on Bitumen

VI. CONCLUSION

Tests were conducted to study the engineering properties of the porous asphalt paving mixes. The results of normal bitumen porous asphalt and crumb rubber porous asphalt were compared to study the effect of crumb rubber on the properties of porous asphalt.

- Marshall Stability of normal bitumen porous asphalt was found to be 24.65kN.
- Average Flow of the sample was 3.9 mm.
- Marshall Stability of 30%crumb rubber bitumen porous asphalt was found to be 39.31kN.
- Average Flow of the sample was 4.2 mm.
- Marshall Stability of 40%crumb rubber bitumen porous asphalt was found to be 23.87kN.
- Average Flow of the sample was 4.53 mm.
- Marshall Stability of 50%crumb rubber bitumen porous asphalt was found to be 18.63kN.
- Average Flow of the sample was 4.53 mm.

Thus the Marshall Stability of crumb rubber porous asphalt was found to be more than that of normal bitumen porous asphalt.

The penetration value of crumb rubber bitumen was less than normal bitumen.

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The softening point of crumb rubber bitumen was higher than normal bitumen.

This concludes that crumb rubber has improved the properties of normal bitumen. The crumb rubber porous asphalt can be used as an alternative over conventional porous asphalt.

The Drainage of normal bitumen porous asphalt was found to be 2.123 ml/sec and that of crumb rubber normal bitumen was 1.950 ml/sec.

As the drainage properties of the normal bitumen porous asphalt is greater than that of crumb rubber porous asphalt this concludes that the voids in normal porous asphalt are filled by the crumb rubber particles which increases the strength of the specimen. The reduction in drainage is not much significant as compared to the increase in strength. Hence, the use of crumb rubber is recommended for increasing the strength of the porous asphalt pavements. The overall properties of porous asphalt are improved by the use of crumb rubber. The crumb rubber porous asphalt can be used as an alternative for conventional porous asphalt in areas where the traffic load is low or moderate. The other implementations of porous asphalt can be for recreational purposes, internal roads in town planning, parking lots etc.

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