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Use of Plastic Waste in Bituminous Road

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Abstract: ***disposal of waste plastic has become a serious problem and waste plastics are thrown out which cause environmental pollution. Utilization of waste obtain in production of recycle plastic pipe may be used as coarse aggregate in the construction of bituminous pavement. In the proposed work we have done experimental study on waste plastic aggregates obtained from recycled pipe waste generated at pipe manufacturing plant and attempted to investigate their feasibility to be used as fully replacement of the natural aggregate.***

The waste coming from the manufacturing process of the pvc pipe is commonly known as gulla waste which contains few stones, metal particles along with major portion of crude, non-recyclable polymer waste. This gulla waste is deployed in shredding machine to convert it in to plastic aggregate. These plastic aggregate is known as waste polymer aggregate (wpa). Various laboratory tests are performed on wpa like percentage water absorption, specific gravity determination, impact, crushing and abrasion value test, stripping test with bitumen, marshall stability test referring the guidelines given by indian standard specifications and indian road congress (irc). The test result outcomes are positive concluding that wpa is feasible to replace the natural aggregate by wpa. The use of the innovative techniques will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. These roads would be a boon for india's hot and extremely humid climate, where temperature frequently cross 50°c and torrential rains create havoc leaving most of the roads with big pot holes.

Keywords: waste polymer aggregate, wpa, recycled pipe, gulla waste, shredding machine.

I. INTRODUCTION

It is estimated that approximately 10 thousand tons per day (TPD) of plastics waste is generated i.e. 9% of 1.20 lacks TPD of total municipal solid waste (MSW) in the country, which is toxic in nature.[1] It is a common sight in both Urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. In order to curtail this problem, experiments have been carried out whether this waste plastic can be reused productively in the construction of roads. Therefore, it is proposed that we may use waste plastic in the construction of Rural Roads.[2]

Nearly 90% of all aggregates are produced from natural resources.[3] Therefore use of waste material in the construction of road and building works will decrease the load on natural resources. Significant research is made on the use of many different materials as aggregate substitute such as coal ash, blast furnace slag, fiber glass waste materials, waste plastics, rubber waste, sintered sludge pellets and others.[4]

In this work polymer waste collected from the plastic industries known as Gulla waste which is cut in cutting machine or in big shredding machine to convert it in to plastic aggregate. These Waste Polymer Aggregates (WPA) are tested in laboratory for Percentage Water Absorption, Specific Gravity determination, Impact, Crushing and Abrasion Value Test, Stripping Test with bitumen, Marshall Stability Test referring the guidelines given by Indian Standard Specifications and Indian Road Congress (IRC). The test results indicate that the waste polymer particles have potential to be used in construction of bituminous road pavement.

II. SOURCE AND PREPARATION OF WPA

Many plastic pipe manufacturing factories use required plastic scrap as their raw material to manufacture rigid pipe and these pipes are called as recycled plastic pipes. In the preliminary stage of manufacturing of recycled plastic pipe the pulverized plastic scrap is melted and is conveyed towards the steel wire mesh in hot condition at a temperature 170- 200^{o}C. This steel mesh is use as the filtering material which rejects the impurities and other foreign particles which are present in plastic scrap, when the rejected plastic scrap which has all the impurities like stone and metal particles with major portion of impure and non-recyclable polymer waste. Collected on either side of the mesh, allowed to cool to and get separated from the steel mesh. The rejected waste is obtained in the form of solid cylindrical shape. This solid cylindrical waste is commonly termed as jali gulla. As this huge amount of non-recyclable polymer waste is produce which is the big problem to disposal in the environment, so this waste is use to study and find the safe way to disposal. This jali gulla is admitted in the big shredding machine to convert it into the shape of the natural coarse aggregate. This obtained plastic coarse aggregate is known as Waste Polymer Aggregate (WPA).

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Figure1. Jali Gulla Material (Solid Cylinder of Waste Polymer)

Figure2. Waste Polymer Aggregates (WPA) obtained from Jali Gulla

III. TESTING OF WASTE POLYMER AGGREGATE (WPA)

The aggregate obtained from the waste polymer jail gulla are studied under different tests to determine their properties. The tests on natural aggregates, which are conducted by Indian Road Congress and Indian Standards on natural coarse aggregate, also are conducted on WPA to judge their suitability as a substitute to natural aggregate.

A. Particle Size and Appearance of WPA

The size of screening attached from underside of a shedding machine decides the range of particle size, when obtaining WPA from *Jali Gulla*. The practical size may vary according to the adjustment of the screening. The maximum size of aggregate required for the test was ranging between 10mm to 12.5mm. The surface was observe rough and the size was irregular similar like the natural aggregate.

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B. Percentage of Water Absorption

This is determined by following the guidelines given in IS 2386 (Part III) of 1963. Oven drying of WPA at specified temperature of 110°C is avoided purposely. Instead Waste Polymer Aggregate is oven dried at a lesser temperature of 65°C for 24 hours and then percentage water absorption is calculated.

C. Specific Gravity Determination

Indian Standard Specification IS 2386 (Part III) of 1963 gives various procedures to find out the specific gravity. In the present work specific gravity of WPA is determined using 6.3mm wire mesh.

D. Determination of Aggregate Impact Value

This test is conducted as per the steps given in Indian Standard Specification IS 2386 (Part IV) 1963. To determine the toughness of WPA.

E. Determination of Aggregate Crushing Value

This test is conducted as per the steps given in Indian Standard Specification IS: 2386 (Part IV) 1963. The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load.

F. Determination of Abrasion Value

This test is conducted as per the steps given in Indian Standard Specification IS: 2386 (Part IV) 1963. Testing of aggregate for its resistance to wear is importance for aggregates to be used for road construction. WPA is also subjected to this test to determine their performance in wear by Los Angeles abrasion value method.

G. Marshall Stability Test

This test is done to determine the Marshall stability of bituminous mixture as per ASTM D 1559. The principle of this test is that Marshall Stability is the resistance to plastic flow of cylindrical specimens of a bituminous mixture loaded on the lateral surface. It is the load carrying capacity of the mix at 60°C and is measured in kg.

IV. RESULT AND DISCUSSION

Above tests are conducted taking three different samples of WPA for each test. The average test results obtained are tabulated below. Little changes are required in the test procedure regarding weight and volume of the sample, heating and oven temperature, percentage addition of bitumen, as base material of the sample is polymer.

Table-1 Properties of WPA with standard results and obtained results.

NAME OF TESTS	*IS CODES*	*IS CODE REFERANCES*	*OBTAINED RESULTS*
Specific Gravity Determination	IS 2386 (Part III) Of 1963	1.5 to 2.9	1.56
Percentage Water Absorption	IS 2386 (Part III) Of 1963	Should not be more than 2%	01.76%
Determination Of Aggregate Impact Value	IS 2386 (Part IV) 1963.	Should not be more than 30%	01.79%
Determination Of Aggregate Crushing Value	IS 2386 (Part IV) 1963.	Should not be more than 30%	01.69%
Determination Of Abrasion Value	IS 2386 (Part IV) 1963.	Should not be more than 30%	02.23%
Marshall Stability Test	ASTM D 1559	Should not be less than 340kg	841kg

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From the above table it is observed that the test conducted on the WPA are within the range as per the IS codes. While performing these tests it is observe that these WPA are light in weight as compare to the natural aggregate. They have the rough surface texture which helps to have stronger bonding between the binding material and WPA. The impact value, crushing value and abrasion value of WPA are much below to the upper limits this explains that WPA has the ability to be used in the construction of the bituminous road. Hence the suitability of the WPA as road pavement constituent is well justified.

V. CONCLUSION

Increasing issue of disposal of the recycled waste polymer plastic and using of natural aggregate in large scale force to study the alternative option for these issues. Executing the present work it concludes that the WPA is feasible for the replacement of the natural aggregate. The WPA has qualified all the tests prescribed by IS codes. A new horizon in the field of road construction can be achieved by practical use of WPA but this is only the laboratory based study it has to extend to the field base study.

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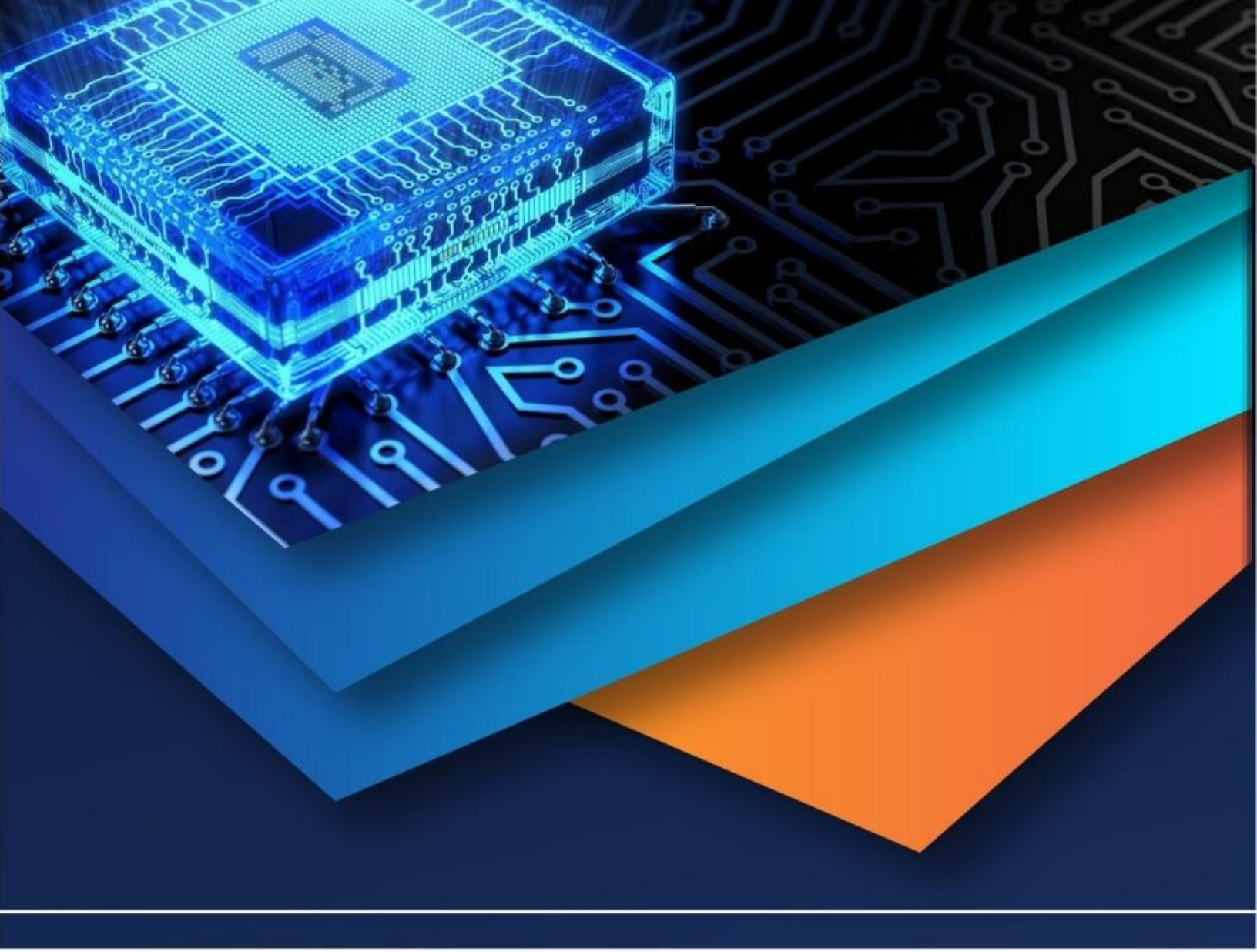

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