

CONSTRUCTION OF HIGHWAY USING INDUSTRIAL WASTE

Md Shah Azam¹, Rachana Verma², Anuj Kumar Sharma³, Mukesh Kumar⁴

^{1,2}B.Tech student, Dept. of Civil Engineering Hi-Tech Institute of Engineering & Technology, Ghaziabad, UP, India

³Asst. Professor, Dept. of Civil Engineering Hi-Tech Institute of Engineering & Technology Ghaziabad, UP, India

⁴Head of Dept. of Civil Engineering Hi-Tech Institute of Engineering & Technology Ghaziabad, UP, India

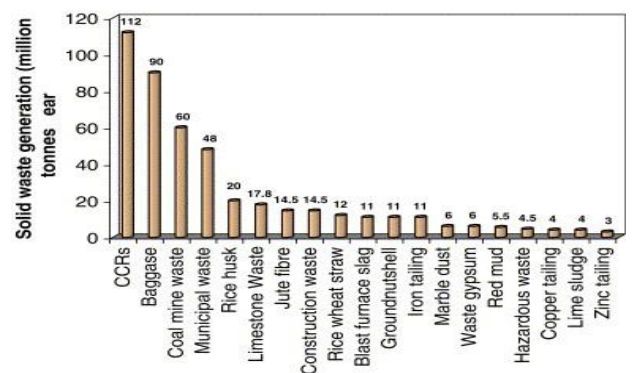
Abstract: In current time the disposal of industrial waste is a big issue in India. Our aim for reducing the disposing problem of industrial waste by the uses of these materials in highway construction. We are using different types of material in highway construction like (fly ash, plastic waste, demolated building material, scrap tires, waste tiles, cement kiln dust etc.). These materials can be suitably utilized in highway construction, we can easily reduce the pollution and disposal problems. A study of different types of Industrial wastes for use in the highway construction has been discussed in this research paper. Waste tires and cement kiln dust is a binder material and these material are very cheap. In current time increase the demand of transportation and everyday increase the industrial wastes. We uses the industrial waste as in the partial replacement of aggregates, soil, stone, sand, bitumen, cement etc. are used for road construction but we are using demolated building material as a filling material and scrap rubber are using for improving the soil stabilization etc. Our main objective is to reduce the disposal problem of industrial waste and also reducing the cost of highway construction.

Key Word: Industrial waste material, soil stabilization

1. Introduction

Disposal issue of the industrial waste material is a challenge so our objective is to working for reducing the disposing problem. In recent time the road is very important for human. Highway pavement should be provided well support in all-weather condition. Wastage material like industrial waste, demolated building waste, household waste, agricultural waste etc. it includes coal ash, plastics, glass, recycled aggregate, rubber tires, ge-naturals, fibers and polythene bags etc. Uses of these waste material to improving the strength of sub grade soils and using composite material like fly ash, coir fiber, and cement kiln etc. chips of rubber tyer can be treated as admixture. Rubber tyer chips can be mixed with soil and can be utilized as various constructions and can be further use in road construction. Highway/Roads are a component of transportation system and it is connected too much country and also connected to village, district. Hence, good road and highway work is a key of development of any country. These materials may be added individually or in combination with soils to

altering the geotechnical engineering. Slag materials have also been used in sustain layers slag cement can be used as the binder for sustain base and sub base layers, slag, cement clay are used as a fine aggregate. It gives to reduce the project cost. Fly ash can be used for construction of embankment and backfills, stabilization of sub-grad and sub-base and rigid and semi-rigid pavement. Cement kiln dust has a chemical composition similar to cement as we also say that the primary value of cement kiln dust is its cementations properties and which are replace the some cement content. The following figure shows the solid waste generation in India.



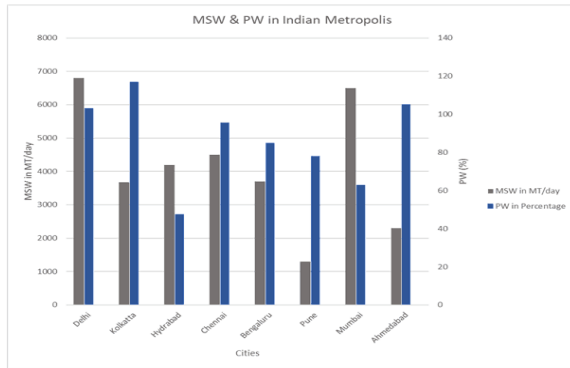
Waste material Generation in India

Types of Industrial Wastes and its applications for using in highway construction

I. Plastic Wastes

The abundant production and usage of plastic is leading the pollution in environment. It doesn't allow oxygen and water pass through it. They are durable, transparent, light and insulated. The polypropylene and polyethylene are used. An application of enhancement the properties of asphalt mixture and the effective modified of the plastics, these two materials were combined together & form the asphalt & used for the construction of highway/path and the properties of the mixture are plasticity resistant, anti-stripping & oil resistant of porous asphalts are improved. It is suitable for the construction of highway and it decrease the wastes of plastic in our country. Than asphalt & the recycled plastic highway are friendlier in environment. It is a best alternative to the standard highway and it reduces the money, effort & time. The plastic helps to the highway to

be durable & strength.



Plastic waste generation in India

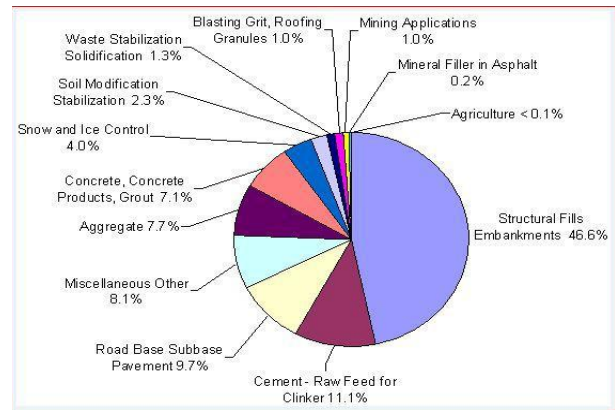
II. Cement Kiln Dust

Cement Kiln Dust is a smooth powdery material, portions of which include some reactive CaO (calcium oxide) based on the location within the dust collecting system, this types of operation, the dust gathering facility and the type of fuel used. Cement is manufacturing by burning mixtures of minerals, lime stone and other additives at high temperatures in a special rotary kiln. Hot air mixing with the raw materials produced a chemical reaction and produces marble-sized pellets, Clinker & sand-sized particles. Cement kiln dust has a cementitious properties & a similar chemical composition as cement. Its alkalinity and particle size provides diversity of beneficial options. Cement kiln dust helps to modify the geotechnical properties of soil in-situ acts as an executor in pozzolanic stabilized base mixture. The adsorptive capacity and cementitious properties allow decreasing the water content and improve the bearing capacity of the soil. Main advantage of using cement kiln dust is it improved the strength of soil and at the same time it decrease time & cost. It can be even mixed with soil to improve the plasticity index or water content to provide desirable altering the properties. Frequently, the maximum particle size of cement kiln dust is about 0.3mm.

III. Blast Furnace Slag

The outgrowth of the steel making industry is blast furnace slag. These raw materials that is utilize in the steel plants are water, fuel, air and power to produce steel. 2-4t of waste is produced during the steel generation. The mixture of silicates & alumina silicates of lime are blast furnace slag. It will initiate anyone lime or Portland cements. The rate of strength of development will be restrain by using the mixture of OPC (ordinary Portland cement) and blast furnace. It decreases the crack resistance of concrete. For the construction of highway coatings, the slag is used basic filler in the asphalt concrete. The durability & carrying capacity of highway/road and runway coatings are grow by using

the blast furnace slag, it is a long acting binder, which make fine in the solidification of materials used for the highway/road construction. The geotechnical properties of blast furnace slag is compressive strength will be modified. The use of blast furnace slag should be enhanced in cement making to decreases the cost of cement manufacturer. In the production of iron, iron ore, iron scrap, and fluxes (limestone and/or dolomite) are charged into a blast furnace along with coke for fuel.



Slag Utilization in different areas



Slag used in sub grade

IV. Marble Slurry

Marble slurry is an expulsion of marble fines in water, which is produced by processing and polishing of marble. Miscellaneous dumping of marble slurry dust create drainage problems/blocks, air pollution, flow regime & damage of agricultural land. Many research works were carried out to protect that the marble slurry dust can be utilized in highway or road pavement layers, concrete works & also in embankments. By using marble slurry dust in highway/road construction it saves the properties of soil & protect the environment.

V. Glass Waste

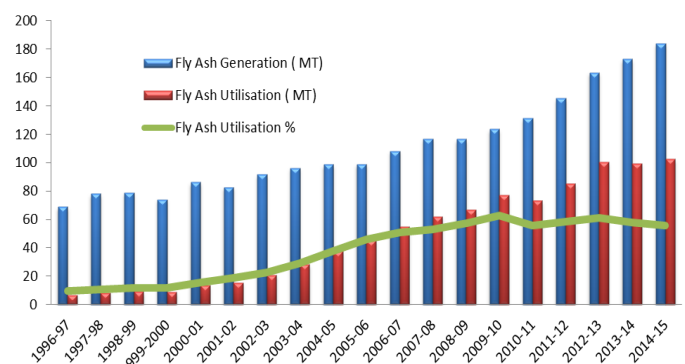
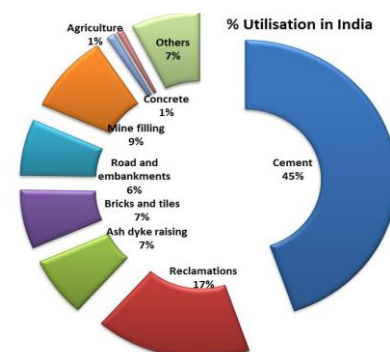
Glass is made from readily-available domestic materials, such as soda ash, limestone, sand & "cullet" and a non-crystalline and often transparent amorphous solid that has widespread practical, technological, and decorative use in, for example, window panes, tableware, and optics the industry term for furnace-ready recycled glass. The only material used in greater volumes than cullet is sand. Glass containers for beverages & food are 100% recyclable, but not with other types of glass. Subsequently field tests with a nuclear density gauge & impact hammer were handle, also laboratory testing of field samples to assess the geotechnical carrying out of the trial sections. The field and laboratory test results show that adding crushed glass may modified the workability of the crushed waste stone base material but afterwards results in lower shear strength. The blend with 15% glass content was found to be the optimum blend, in which the material availability good workability and also had enough high base strength. Therefore, cullet glass and domestic glass waste can be used in asphalt concrete mix as mineral filler material according to the Marshall method, the use of the glass waste in hot mix asphalt pavements would be very useful in view of waste management.

VI. Fly Ash

Fly ash or flue ash, also known as pulverized fuel ash in the United Kingdom, is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. The minor constituents of fly ash depend upon the specific coal bed composition but may include one or more of the following elements or compounds found in trace concentrations (up to hundreds ppm): arsenic, boron, beryllium, cadmium, chromium, cobalt, hexavalent chromium, lead, mercury, molybdenum, manganese, strontium, selenium, vanadium and thallium, along with very small concentrations of dioxins and PAH compounds. It also has unburnt carbon. Fly ash is the finely split residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. In coal fired electric and steam generating plants the fly ash is generated. Fly ash is suitable for wide range of applications because of its features like outstanding and multifarious properties. The concrete, cement, bricks, pavers etc are the construction materials that have content of fly ash. Fly ash as a finally divided mineral residue of burning of coal exhibits the superb pozzolanic properties and geotechnical and so it is suitable for highway/road constructions. In rural sectors the fly ash and fly ash based products built, they have the properties like ecofriendly, durable and economic. On large scale these products are technologies were carried through it helps to ecofriendly and sustainable

constructions and new business opportunities of employments. The important parameter of fly ash soil mixture is its unit weight, since it manage the permeability, strength and compressibility. The engineering properties are modified by the densification of ash.

S.No.	Country	Annual ash production, MT	Ash utilization %
1	India	112	38
2	China	100	45
3	USA	75	65
4	Germany	40	85
5	UK	15	50
6	Australia	10	85
7	Canada	6	75
8	France	3	85
9	Italy	2	100



Utilization of Fly Ash in India

VII. Rice Husk Ash

Rice husks or rice hulls or are the hard protecting coverings of grains of rice. In addition to conservation rice during growing season, it is used as building material, fertilizer etc. RHA (Rice Husk Ash) contains amorphous silica. Husk generated during milling is mostly used as a fuel in the paddy boilers. About 20 million tons of RHA (Rice Husk Ash) is produced annually. This material cause's environment ultimatum, when this material is disposed it causes damage to the land, environment and surrounding area. Recent

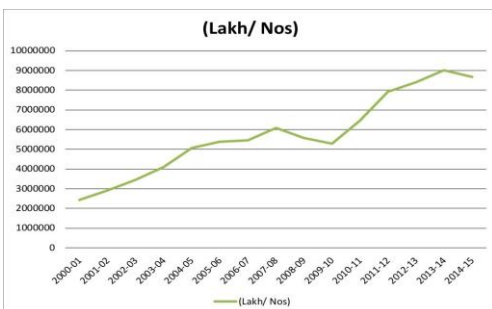
research on Pozzolanic activity found that RHA (Rice husk ash) is a conceivable material which can be utilized for the modified of soil. RHA (Rice Husk Ash) is mixed even with the cement to fill the voids and to improve the density and strength.



Rice Husk Brick

VII. Scrap rubber tire

The generation of scrap tires has been increased over the years in the world. The common practice used for disposal of the waste tires such as stock piles, and fills and burning are considered as very dangerous to health of humans and ecological system. The main objective is to increase the strength and to reduce the construction cost by using scrap rubber material. The scrap rubber used in the form of crumb rubber powder (CRP). CRP used for embankment construction. It improve the strength of road and life. It also reduce the disposal



problem of scrap rubber. India is one of the developing countries, In India there is a very fast annual increase in the number of vehicles leading to steady increase in the volume of consumption of waste rubber tires year by year, and it has been observed that the production of tires and tube has been increased in every day. Thus, it reduces the impact of rubber on environment.

Waste rubber tyre generation (Indian scenario)

2. OBJECTIVE OF THE STUDY

- In developing countries like India. Transportation is most important requirement for economic and social development. The use of these materials in highway/road making is based on technical, economic, and ecological criteria. The pollution and disposal problems can be partly reduced
- In every year several million metric tons industrial wastes are produced in these establishments. In the same time, the sustainable development concept requires a more efficient management of waste materials and preservation of environment
- To alter the geotechnical properties of soil by using scrap tires as a stabiliser.
- The laboratory experiments conducted, to evaluate their properties.
- Analysis and interpretation of result.

3. SUMMARY OF LITERATURE REVIEW

❖ K. Aravind & Animesh Das, Department of Civil Engineering, IIT Kanpur

- In this research the traditionally soil, stone aggregates, sand, bitumen, cement etc are used for road construction. Researcher found that optimum materials can be suitably utilized in highway construction and associated problem of pollution and disposal had partly reduced.
- Natural materials have a limit. In nature, its quantity is declining gradually. Also, cost of these extracted good quality of natural material is increasing.

❖ Mamta Mishra, Department of Civil Engineering, K.N.I.T, Sultanpur

- Researcher also observed that Blast furnace slag can be used in soil stabilization due to its hardening property when exposed to moisture furnace slag provides a great potential effective use of this waste material and produces alternate binder to cement.
- Coal fly ash Light weight, can be used as binder in base course in stabilization to pozzolanic property, Fly ash is an effective agent for chemical or mechanical stabilization of soils and Recycling and reuse of the waste materials are found to be an appropriate solution to the problems of dumping hundreds of thousand tons of waste on natural soil, which will result in consumptions in natural materials required for all construction activities.

❖ **Chunhua Han (Ph.D.) Department of civil engineering, MNIT, Allahabad.**

- Researches concentrated on waste materials as replacements for highway aggregates and were summarized by two comprehensive Synthesis studies.
- The first NCHRP synthesis study conducted by the University of Illinois in 1972, explored the possibility of producing synthetic aggregates, benefit of re-using unsuitable materials, and use of manufactured and waste materials as supplements and replacements for conventional aggregates in highway construction.
- As a result, this study led to three kinds of research projects: characterization of acceptable aggregates, application of plastics to improve aggregates, and identification and cataloging of raw materials for use in the manufacturing of synthetic aggregates.

❖ **P. T. Ravichandran, A. Shiva Prasad, K. Divya Krishnan and P. R. Kannan Rajkumar Department of Civil Engineering, SRM University, Kattankulathur**

- Crumb rubber powder mixed with both the soil showed improvement in CBR value with its addition up to 10% and there onwards decreased with further increase in crumb rubber powder.
- The permeability value shows a rapid increases with the increase in crumb rubber content for the both the soils.
- The use of crumb rubber as a stabilizer introduces a low cost method for stabilization and it significantly reduces the waste tire disposal problem that currently exit.

❖ **Imtiaz Ahmed and C. W. Lovell, Department of Civil Engineering, Purdue University, West Lafayette, Indiana(U.S.)**

- An evaluation based on technical, environmental, and economic factors indicated that reclaimed paving materials, coal fly ash, blast furnace slag, bottom ash, boiler slag, steel slag, and rubber tires have significant potential to replace conventional materials for various applications in highway construction and should be projected for future construction.
- Technical economic, and environmental problem associated with various applications of waste materials, identified under each waste material and briefly discussed must be addressed before extensive use of these waste products in highway construction.

4. RESEARCH METHODOLOGY

Materials

Materials used in the present study are the following

- Aggregates
- Plastics
- Bitumen
- slag
- Fly ash
- Cement kiln dust

Segregation process: Plastic waste collected from various sources is separated from other wastes.



Segregation of plastic

Cleaning process: Plastic waste is cleaned and dried.



Cleaning of plastic

Shredding process: Plastics will be shredded or cut into small pieces.



Shredded plastic

Collection process: The plastic waste retaining on 2.36 mm IS sieve is collected.



Collection of shredded plastic

Testing of materials: These following test methods are conducted.

1. Following are the tests to be performed on aggregate:

- a) Los Angeles abrasion test
- b) Specific gravity test
- c) Stripping value test
- d) Aggregate impact value test
- e) Water absorption test

2. Following are the tests to be performed on bitumen:

- a) Ductility test
- b) Softening point test
- c) Penetration value test
- d) Flash & fire point test

- Preparation of sample: Six Marshall Stability samples will be made ready out of which three will be with the plastic of different percentage (4.5%, 9%, and 15%) and three samples without plastic waste.
- Execute Marshall Stability test: Marshall Stability test will be conducted on all of the samples prepared.

6. RESULT

Following are the tests performed and the results obtained

Test for plastic waste

1. TESTS ON AGGREGATE

Results of tests on aggregate

Stone Aggregate	Plastic Content (%)	Los Angeles Abrasion Value	Specific Gravity	Aggregate Impact Value	Water Absorption	Stripping Value
Without Plastic	0	12.83 %	2.5	1.77 %	3.23%	1%
With Plastic	10	11.73 %	2.65	9.29 %	2.1%	0%
	15	10.68 %	2.71	8.90 %	1.14%	0%

TESTS ON BITUMEN

Results of tests on bitumen

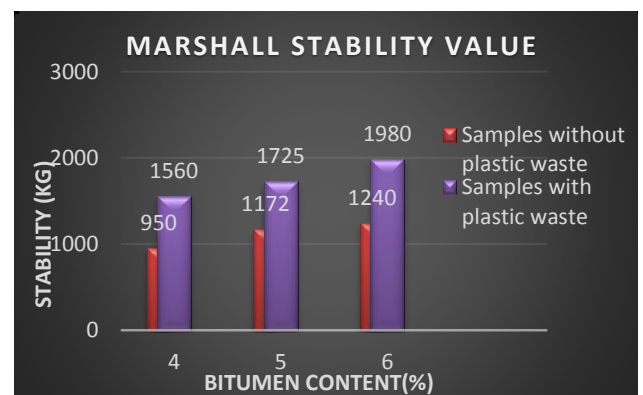
Test	Result	Range
Penetration value	85 mm	80-100 mm
Ductility test	76.50 cm	Minimum 40 cm
Softening point	48.20°C	45-60°C
Fire point test	305°C	> 175°C
Flash point test	283°C	

MARSHALL STABILITY TEST

Marshall Stability and flow value

Sample No.	Bitumen content (%)	Plastic content (% by weight)	Marshall stability (kg)	Flow value (mm)
1	4	0	950	3.1
2	5	0	1170	3.3
3	6	0	1240	3.6
4	4	5	1560	3.9
5	5	10	1720	4.5
6	6	15	1980	5

Stability (kg) and bitumen content (%)



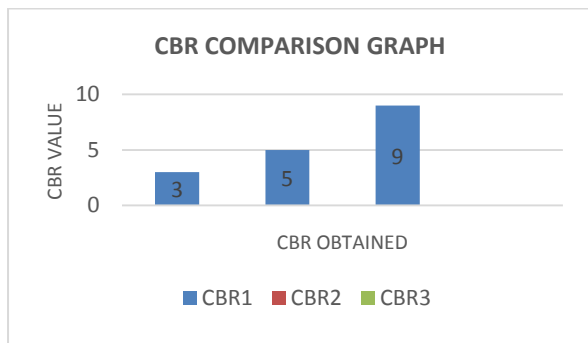
Properties of aggregate (75%) + iron slag (25%) mix and Normal aggregates

S. NO	Properties	Aggregates	Iron Slag (25%) + Aggregates (75%)	IS Specifications
1	Abrasion (%)	33.50	36.98	Max. 30
2	Crushing (%)	24.90	28.29	Max.30
3	Impact (%)	16.81	23.88	Less than 30
4	Specific gravity	2.85	2.62	2.6-2.9
5	Water absorption	0.37	0.12	1

Test for fly ash

CBR Tests on stabilized soil

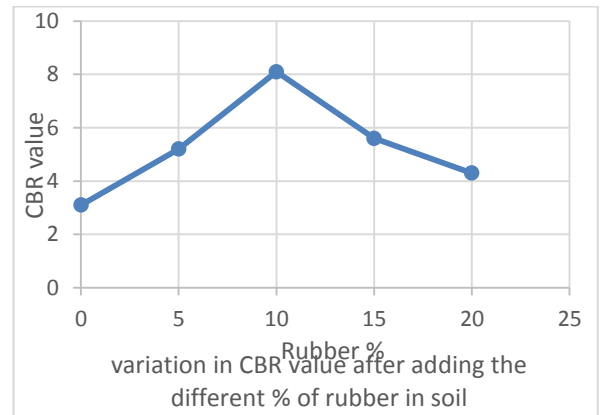
SL NO.	Name of the test	OBTAINED CBR VALES
01	Basic CBR test on Soil	5.52% (Unsoaked) 3.45% (Soaked)
02	CBR test on soil + flyash 30%	7.60% (Unsoaked)



CBR of soil + fly ash

- 1. CBR value of the soil unsoaked in percentage = 5.52%
- 2. CBR value of the soil soaked in percentage = 3.45%

CBR test for Soil + scrap rubber



7. CONCLUSION

Cement kiln dust can be used to improve the properties of soil and we use as a filler material for embankment construction, and as a generator, in pozzolanic stabilized base mixtures. The adsorptive capacity and cementitious effects of cement kiln dust give it to reduce the water content and increase the bearing capacity of the soft soil. Cement kiln dust can be mixed with soil to modify water content or plastic limits to provide the desired stabilized properties. Fly ash and lime can be mix with aggregate to generate a quality stabilized base course. Fly ash is an effective agent for mechanical or/and chemical stabilization of soils. By improving subgrade conditions by using fly ash, upgrade cost savings through reduction in the required pavement thickness due to increase in CBR value of subgrade. From the investigation of the behavior of plastic waste modified BC, we can conclude that the modified mix possesses enhance Marshall Characteristics. It is observed that Marshall Stability value improve with plastic content and we observed that the Marshall Flow value reduce upon addition of polythene i.e. the resistance to distortion under heavy wheel loads increases. From all the experiments performed we can conclude that the addition of plastic waste improve the various properties of an ordinary bituminous road. Blast furnace slag has been used as a cementitious binder in highway/road construction. Blast furnace slag provides a great Cement kiln dust can be mixed with soil to improve moisture content or plastic limits to provide the desired stabilized properties conceivable for profitable use of this waste material and produces alternate binder to cement. And in the construction of highway fly ash use in bulk fill, artificial aggregates, filler in bituminous mix. Blast furnace slag (BFS) use in sub-base/base material, Binder in soil stabilization (ground slag). Cement kiln dust uses in stabilization of base, binder in bituminous mix. Waste tyres use in Rubber modified bitumen or a partial place of aggregate, and also use in stabilization of soil properties. Construction and demolition (cNd) waste

used in sub-base/base material, or as a bulk-fill. In many cases, BFS has been used as the single source of material for gravel road construction. In other case, blast furnace slag used for roadbed, sub base, or base course material. By the uses of industrial waste in highway/road construction it decreases the cost of construction and help to controlling the pollution. The use of the inventive technology helps to strengthen the road construction and also increases the road life.

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Author Profile



Md Shah Azam B.tech in Civil Engineering from Hi-Tech Institute of Engineering & Technology, Ghaziabad, Uttar Pradesh, (India) affiliated to Dr. A.P.J. Abdul Kalam Technical University, Lucknow, Uttar Pradesh (India).



Rachana Verma B.tech in Civil Engineering from Hi-Tech Institute of Engineering & Technology, Ghaziabad, Uttar Pradesh, (India) affiliated to Dr. A.P.J. Abdul Kalam Technical University, Lucknow, Uttar Pradesh (India).



Anuj Kumar Sharma Assistant Professor in the department of Civil Engineering, at Hi-Tech Institute of Engineering & Technology, Ghaziabad, Uttar Pradesh, (India).