A Study of Various Types of Industrial Wastes Used in Road Construction

Nitin, M.Tech Scholar, Department of Civil Engineering, Jagannath University, NCR, Haryana.

Parveen Yadav, M.Tech Scholar, Department of Civil Engineering, Jagannath University, NCR, Haryana.

Vijay Dahiya, Supervisor, Assistant Professor & Head, Department of Civil Engineering, Jagannath University, NCR, Haryana

Abstract:

Presently a day's transfer of various mechanical squanders is a significant issue. As the quantity of enterprises and processing plants are rising definitely, there is a need to know the advantages of waste materials which can be reused and reused in some other structures. The most reasonable technique for usage of these industry squander materials is receiving them in development. In a significant number of the exploration works it is demonstrated that the waste materials delivered by enterprises can be used in street asphalts. Huge amount of squanders is delivered in these foundations. The contamination and transfer of waste material can be somewhat diminished by utilizing in development. Numerous Researchers have built up the particulars of street development utilizing mechanical squanders which thus can be conceivable to return higher financial aspects [1]. The contamination and transfer issues can be limited by using these materials in street developments. Nowadays coarse and fine totals are supplanted halfway with modern waste materials. Taking into contemplations that common materials are getting depleted in nature and amount is diminishing bit by bit likewise the extraction of good quality materials are extremely monetary, researchers are searching forward for the improvement and use of modern squander materials in street development. Taking into considerations that natural materials are getting exhausted in nature and quantity is decreasing gradually also the extraction of good quality materials are very economic, scientists are looking forward for the improvement and utilization of industrial waste materials in road construction.

.

Introduction

The main objective of this study is to search for additional waste products which are feasible for use in road construction technically, economically and eco-friendly. The usage of these materials doesn't compromises the quality and performance of the highway infrastructure and not to create any damages to environmental pollutions. The main reasons of the increment of wastes are growth of population, urbanization and industrialization. The necessary specifications are required to maximize the use of industrial waste in different layers in road construction. The two benefits are: (a) Help to clear valuable and huge dumps of wastes and (b) Help to preserve the natural reserves of aggregates. Therefore, proper utilization of waste materials depends on its use how these materials are being economical competitive with that of the currently used natural materials, including the cost of processing and transportation. Different types of Industrial waste in both road sub grade and sub-base are Fly ash, Cement kiln dust (CKD), Phosphogypsum, Red mud, copper slag, Marble slurry, foundry sand, rice husk ash, plastic waste, glass wastes, steel slag, blast furnace sludge etc. Plastic is the most widely used material in the present times. It is light in weight, moisture resistant, flexible and very inexpensive. These qualities increase our propensity towards plastic and hence making its use very common. Today plastic is used in every vital sector of the economy, ranging from agriculture to automobile, electronics, construction, etc. It has revolutionized all spheres of life. But this plastic ultimately becomes a waste. It is a common site both in urban and rural areas to see plastic wastes littering the roads. It forms the major portion of the total municipal solid wastes (MSW). Tons of plastic wastes which include polyethenes, cups, bags, etc. are discarded every year, polluting land, rivers, seas, oceans, etc. plastic is a non-biodegradable material and it has been found that it can remain on earth for about 4500 years without showing any signs of degradation. Its improper disposal can cause serious health hazards in humans. Based on the present usage scenario of plastics, its complete ban will not be justified; hence we have to find the alternatives to reuse the plastics.

Types of Industrial Wastes and its applications

Plastic Wastes

Plastic paths are made entirely of plastic or of composites of plastic with other materials. Plastic roads are different from standard roads in the respect that standard roads are made from asphalt concrete, which consists of mineral aggregates and asphalt. Currently, there are no records of regular roads made purely of plastic.Plastic composite roads, however, have existed and demonstrate characteristics superior to regular asphalt concrete roads; specifically, they show better wear resistance. The implementation of plastics in roads also opens a new option for recycling post consumer plastics. Australia, Indonesia, India, the United Kingdom, the United States, and many other countries have used technology which can incorporate plastic waste into an asphalt mix.

The plastic waste quantity in municipal solid waste is increasing due to increase in population and changes in life style. Thus disposal of waste plastic is a hazardous and become a serious problem globally due to their non-biodegradability. Plastic roads are found to perform better than ordinary roads and therefore use of plastic road construction has gained importance these days. Disposal of waste plastic bags has become a serious problem and waste plastics are burnt for disposal which causes environmental pollution. Utilization of waste plastic bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Waste like plastic bottles, polymers, cups, etc. can be re-used by powdering or blending it with crusher and can be coated over aggregate and bitumen by any heating process. This paper describes the various aspects of utilization of plastic waste in construction of roads. Plastic is the most widely used material in the present times. It is light in weight, moisture resistant, flexible and very inexpensive. These qualities increase our propensity towards plastic and hence making its use very common. Today plastic is used in every vital sector of the economy, ranging from agriculture to automobile, electronics, construction, etc. It has revolutionized all spheres of life. But this plastic ultimately becomes a waste. It is a common site both in urban and rural areas to see plastic wastes littering the roads. It forms the major portion of the total municipal solid wastes (MSW). Tons of plastic wastes which include polyethenes, cups, bags, etc. are discarded every year, polluting land, rivers, seas, oceans, etc. plastic is a non-biodegradable material and it has been found that it can remain on earth for about 4500 years without showing any signs of degradation. Its improper disposal can cause serious health hazards in humans. Based on the present usage scenario of plastics, its complete ban will not be justified; hence we have to find the alternatives to reuse the plastics. It is estimated that approximately 10 thousand tons per day (TPD) of plastics waste is generated i.e. 9% of 1.20 lacs TPD of MSW in India.The abundant production and usage of plastic is leading the environmental pollution. It does not allow water and oxygen pass through it. The plastics are durable, light, transparent and insulated. The polyethylene and polypropylene are used. An implementation of improvement of the properties of asphalt mixture and the effective recycle of the plastics, these two materials were combined together and form the asphalt and used for the construction of roads and the properties of the mixture are fluidity resistant, oil resistant and anti-stripping of porous asphalts are improved. It is suitable for the construction of road and it reduces the plastic wastes in the country [7]. Than asphalt, the recycled plastic roads are more environmental friendly. It is a great alternative to the conventional roads and it reduces the time, money, and effort. The plastic helps the roads to be durable, strength and mold ability.

Fly Ash

Fly ash is the finely divided 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 produced. Fly ash is suitable for wide range of applications because of its features like excellent and multifarious properties. The cement, concrete, bricks, pavers etc are the construction materials that include the content of fly ash. Fly ash as a finally divided mineral residue of burning of coal exhibits the excellent geotechnical and pozzolanic properties and so it is suitable road constructions. In rural sectors the fly ash and fly ash based products established, they have the properties like durable, ecofriendly and economic. On large scale these products are technologies were implemented it helps to ecofriendly and sustainable constructions and new business opportunities of employments [5]. The advantages of fly ash are: ultimate strength is high, improved workability, decrease bleeding, heat of hydration decreases, low permeability, low cost, increase durability, decreases shrinkage [1]. The geotechnical properties of fly ash soil mixtures like compaction, unconfined compressive strength, permeability are in satisfactory limits. Tremendous research work was progressed on utilization of fly ash in the various construction works including road sub bases and subgrades. The important parameter of fly ash

soil mixture is its unit weight, since it controls the strength, permeability and compressibility. The engineering properties are improved by the densification of ash.

Blast Furnace Slag

The result of the steel making industry is impact heater slag. The five crude materials that is use in the steel plants are air, water, fuel and capacity to create steel. 2-4t of waste is created during the steel generation [8]. The blend of silicates and alumina silicates of lime are impact heater slag. It will initiate anybody lime or Portland concretes. The pace of solidarity of advancement will be hinder by utilizing the blend of impact heater and customary Portland bonds. It decreases the split opposition of cement. For the development of street coatings, the slag is utilized essential filler in the black-top cement. The conveying limit and toughness of street and runway coatings are expanded by utilizing the impact heater slag, it is a long acting fastener, which make smooth in the cementing of materials utilized for the street development. The geotechnical properties of impact heater slag is compressive quality will be expanded. The utilization of impact heater slag ought to be upgraded in concrete making to decrease the expense of bond producer. The investigations completed on impact heater pipe residue created at steel plants have demonstrated that the majority of the carbon esteems can be recuperated either by cell or segment buoyancy methods The byproduct of the steel making industry is blast furnace slag. The five raw materials that is utilize in the steel plants are air, water, fuel and power to produce steel. 2-4t of waste is generated during the steel production [8]. The combination of silicates and alumina silicates of lime are blast furnace slag. It will activate anyone lime or Portland cements. The rate of strength of development will be retard by using the mixture of blast furnace and ordinary Portland cements.

Foundry Sand

Foundry sand is generated by the foundry industry and it is of huge quantity. The disposal of it becomes environmental, economic and social barrier. It is a dangerous waste. This waste is convenient as the sub base layer. It satisfies the geotechnical functions and environmental prescriptions to minimize the environmental pollution. The foundry sand was used as the embankment fill material, an aggregate alternative in asphalt concrete and the aggregate to controlled low strength material . In hot mix asphalt pavements, the foundry sand is used as an alternative material to fine aggregate. It shows a satisfactory performance. Another possible use of foundry sand is an anti-skid material for roads covered with snow and ice. The highway embankments a flow able fills are the major applications. The increase in foundry sand lowers the workability. The conserve landfill capacity and sands are conserved by reusing the foundry sands. The Geotechnical properties determine by conducting the tests like proctor's compaction test, California bearing ratio test, unconfined compression test, liquid limit, plastic limit, shrinkage limit and plasticity index are in satisfactory limits to use this waste material in road constructions .

Sugarcane Straw

The sugarcane straws are made from reusable sugarcane fiber, which is not only a natural source for the material but is also biodegradable. The wastes from the sugarcane industries have been found out to be pozzolanic material. Sugarcane straw ash has a lower specific gravity compared to that of the soil. By considering the sugarcane straw as a filler in the soil voids and the decrease in MDD may also be explained. The increase in OMC with increase in sugarcane cane ash implies that more water content is needed in order to compact the soil -sugarcane straw mixture. The sugarcane straw ash can be used to improve the engineering properties of the soil but it is not a good stabilizer. The optimum % of the sugarcane straw ash by weight the soil for improvement in the strength characteristic of the soil sample is 4%. .

Glass Waste

Glass is made fromreadily-available domestic materials, such as sand, soda ash, limestone and "cullet," the industry term for furnace-ready recycled glass. The only material used in greater volumes than cullet is sand. Glass containers for food and beverages are 100% recyclable, but not with other types of glass. Subsequently field tests with a nuclear density gauge and Clegg impact hammer were undertaken, as well as laboratory testing of field samples to assess the geotechnical performance of the trial sections. The field and laboratory test results indicated that adding crushed glass may improve the workability of the crushed waste rock base material

but subsequently results in lower shear strength. The blend with 15% glass content was found to be the optimum blend, in which the material presented good workability and also had sufficiently high base strength. Higher recycled glass content (30%) resulted in borderline, though still satisfactory, performance. The research findings indicate that recycled crushed glass in blends with crushed waste rock is a potential alternative material to be used in footpath bases. With an increase in limestone filler material ratio there is a decrease in stability. Maximum stability is obtained at 5% filler content. The specific gravity and air voids filled with bitumen values are not affected by the change in mineral filler ratio. With the increase in limestone filler ratio the air voids decreases. Cullet glass dust material, The stability increases with the increase in filler and then the stability decreases with the increase in filler. Air void ratios are smaller. The maximum specific gravity was obtained for 9% cullet glass dust. Domestic glass waste dust: the stability increases with the increase in filler ratio. Max SG was obtained for 9% domestic glass. 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 .

Copper Slag

Copper slag is a by-product of copper extraction by smelting. During this process, all the impurities become slag which floats on the molten metal. Ground granulated slag is often used in concrete in combination with Portland cement as a part of blended cement. Ground granulated slag reacts with water to produce cementitious properties. The produced slag which is quenched in water produces angular granules which are disposed as wastes. Copper slag is not a eco-friendly material. The use of copper slag aggregates in hot mix asphalt pavements improves the stability. It rather acts as a conventional coarse and fine aggregate for hot mix asphalt pavement.

Cement Kiln Dust

Cement Kiln Dust is a fine powdery material, portions of which contain some reactive calcium oxide depending on the location within the dust collected system, the type of operation, the dust collection facility and the type of fuel used. Cement is produced by burning mixtures of lime stone, minerals and other additives at high temperatures in a special rotary kiln. Hot air mixing with the raw materials creates a chemical reaction and produces Clinker, marble-sized pellets and sand-sized particles. Cement kiln dust has a similar chemical composition as cement and it has cementitious properties. Its alkalinity and particle size provides variety of beneficial options. Cement kiln dust helps to improve the properties of soil in-situ acts as an activator in pozzolanic stabilized base mixture [3]. The adsorptive capacity and cementitious properties allow reducing the moisture content and increases the bearing capacity of the soil. Main advantage of using cement kiln dust is it improves soil strength and at the same time it reduces cost and time. It can be even mixed with soil to modify the plastic limits or moisture content to provide desirable stabilized properties. Typically, the maximum particle size of cement kiln dust is about 0.3mm .

Phosphogypsum

Phosphogypsum refers to the gypsum formed as a by-product of processing phosphate ore into fertilizer with sulphuric acid. It is a radioactive due to the presence of naturally occurring Uranium and radium in the phosphate ore. There are approximately five tons of Phosphogypsum produced for every ton of phosphoric acid produced. Phosphate production generates large amount of wastes. The specific gravity of Phosphogypsum ranges from 2.3 to2.6. Bulk density ranges from 1470 to 1670kg/m^3 based on standard proctor compaction [18]. Presently alternative uses of waste-Phosphogypsum are considered in several countries as it has long-term storage capacity and better maintenance, presents economics as well as environmental concerns.

Conclusions

The utilization of different types of industrial wastes in road construction is reviewed by knowing its physical, mechanical and durability properties of each one of it. The use of the innovative technology helps to strengthen the road construction and also increases the road life. An evaluation based on technical, environmental and economic factors shows fly ash, blast furnaces slag, foundry sand and plastic wastes have a significant potential to replace the conventional materials for the different applications in road construction. . Few studies have been done concerning the strength, durability, stability, environment aspects for using the industrial wastes appropriately and carefully. The generation of waste plastics is increasing day by day. The plastics show adhesion property in their molten state. Plastics

will increase the melting point of the bitumen. Hence, the use of waste plastics for pavement is one of the best methods for easy disposal of waste plastics. Moreover, plastic is not recyclable and using them in road construction will help in the disposal of these plastic wastes in an eco-friendly manner. The use of the innovative technology will not only strengthen the road construction but also make it economical as well as increase the life span of roads. Plastic roads will be most feasible for a country like India, where temperature is around 50oC and the heavy monsoons too create havoc, leaving the roads with potholes and ruts. It is hoped that in near future we will have strong, durable and eco-friendly roads that will relieve the earth from all type of plastic waste.

References

[1]. Brajesh Mishra, Ravi Shanker Mishra M. Tech., Assistant Engineer, U.P. Cane Development Department, Lucknow, India Professor & Head Department of Civil Engineering, AIMT, Lucknow, India:"A Study on Use of Industrial Wastes in Rural Road Construction":International Journal of Innovative Research in Science, Engineering and Technology(An ISO 3297: 2007 Certified Organization) Vol. 4, Issue 11, November 2015.

.**[2].** K. Aravind and Animesh Das "Industrial Waste in highway construction".

[3]. Imtiaz Ahmed"Use of waste materials in highway construction", Publication FHWA/IN/JHRP-91/03.Joint highway research project, Indian department of transportation and Purdue University, West Lafayette,Indiana,1991).

[4]. Louter, Bos, Belis, Veer, Nijsse(Eds)"Innovative glass receipes containing Industrial wastematrials", challenging glass 6-conference on architectural and structural applications of glass,Delft university of technology ,May 2018) .

[5]. Vimal Kumar, "Overview of fly ash for use in rural development", Workshop on non conventional materials/ technologies,18th Feb 2012, Central road research institute, New Delhi).

[6]. Fabio Santos, Lin Li, Yaong Li, and Farshad Amini, "Geotechnical properties of fly ash and soil mixture for use in highway embankments" ,World of coal Ash conference, May 9-12,2011).

[7]. Osamu Kamada and Massaru Yamada, "Utilisation of waste plastics in asphalt mixtures", Osaka university, Vol43, PP 111-118, 2002.

[8].B.Das, S. Prakash, PSR Reddy,V N Misra, "An overview of utilization of slag and sludge from steel industries", Regional research laboratory, Mineral processing and Energy technology department, Bhubaneswar, Orissa 2006).

[9]. Nagasjur, PPT "Use of Blast furnace slag in road construction"- Nagasjur, civil department, NIT Raichur).

[10].O.Yazoghli Marzouk, A.Jullien, "Recycling foundry sand in road construction – field assessment", 2014.

[11]. Javed S " Use if waste foundry sand in highway construction", joint highway research project, Indian department of transportation and Purdue university, West Latayette, India, 1994).

[12]. User guidelines for waste and byproduct materials in pavement construction,Federal highway administration research and technology, coordinating ,developing and delivering highway transportation innovations, publication number : FHWA- RD-97-148)

[13]. Jais Jose, Nirmal Raju Jose, Amruth P M , Ghanashayam S, Dr. Solly George "Effect of foundry sand on geotechnical properties on marine clay", B Tech students for Mar Athansius college of Engineering Kothamangalam,Kerala,India).

[14]. Agbedc, L.O and Joel," Effect of the rice husk ash on the properties of the burnt clay bricks" .American Journal of scientific and industrial research, PP674-677, 2011.

[15]. A.K Misra, Renumathur, Y v rao, A P Singh and Pankaj Goel "A new technology of marble slurry waste utilization in roads"Central road research institute (CRRI) New Delhi, Journal of scientific and industrial research vol-69.January 2010.

\