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# Use of Industrial Waste Materials in Road Construction

Mamta Mishra
*Department of Civil Engineering,*
*Kamla Nehru Institute of Technology, Sultanpur, Uttar Pradesh, India*

***Abstract: There are many types of waste material found in India like industrial, building, household, agricultural etc. it includes coal ash, stone quarry, plastics, glass, recycled aggregate, geo-naturals, fibers and polythene bags etc. One of the best solutions to use the waste material to improve the strength of sub grade soils is by using any one or composite material of lime, fly ash, coir fiber etc. In this paper we describe the use of industrial waste material in road construction.***
***Keywords: Road construction, Industrial waste, Steel slag, Cement kiln dust, Blast furnace slag, Fly ash.***

## I. INTRODUCTION

Road surface should be smooth and unyielding to enable free movement of vehicles. Road is very important for all human. Road pavement should provide good support in all seasons. Road pavement is two types such as: Flexible pavement and rigid pavement. India, being the seventh largest country in the world, its requires a, network of structures and roads to serve its large population. The land available for any construction is very less because of increasing urbanization and modernization. For such type of large structures for road surfaces, a large amount of construction materials like suitable earth, stone aggregates binders etc. This will impose heavy pressure on limited resources and therefore, for sustainable development use of locally available materials, waste material should be encouraged in order to save the natural resources for future generation. Waste material like industrial, building, household, agricultural etc. it includes coal ash, stone quarry, plastics, glass, recycled aggregate, geo-naturals, fibers and polythene bags etc. Use the waste material to improve the strength of sub grade soils is by using any one or composite material of lime, fly ash, coir fiber etc. This will result in reduction of overall thickness of pavement and saving of construction materials. Literature suggests that in recent times, fly ash, cement and other materials have been extensively used in the construction of embankment and highways. Traditionally soil, stone aggregates, sand, bitumen, cement etc. are used for road construction. Natural materials being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing. Engineers have been always with open mind to adopt any material available to them for its use for the construction purposes. Research facilities at hand help them to judge the suitable of the materials.

Sen and Mishra (2010) gave a review of various Industrial wastes for use in the construction of highway. Kolisetty and Chore (2013) described optimum utilization of waste materials in some construction activities. They described how to utilize different waste material for civil engineering works. Anupama et al. (2013) it is represented a study on the usefulness of agricultural and industrial waste as a soil admixture, and focused to improve the engineering properties of soil to make it capable of lower layer (sub- base and base coure) of road construction. In their study they describes the behavioral aspect of soils mixed with industrial waste materials viz. fly ash (FA), rice husk ash (RHA) & bagasse ash (BA) and agricultural waste material rice straw ash (RSA) to improve the strength and load bearing capacity of the soil. Mishra and Mishra (2015) also carried out a study on o safe disposal of industrial wastes. There studies reveal that in recent years, industrial wastes are successfully used in soil improvement and road construction in many developed countries. The use of these materials (industrial waste) in road making is based on technical, cost and ecological criteria. Prabakar et al. (2004) studied influence of fly ash on soils and reported that the addition with fly ash reduced the dry density of the soil due to the low specific gravity and unit weight of soil and improved the shear strength. The common waste materials are fly ash, blast furnace slag, cement kiln dust, phosphogypsum, waste plastic bags, foundry sand and colliery sand. Bolden et al (2013) examines aspects of preparing construction materials based on recycled and industrial waste products. Beeghly (2003) gave an observation on the basis of experimentation that lime and fly ash(LFA) can offer cost savings by reducing material cost by up to 50% as compared to Portland cement stabilization. Bhuvaneshwari et al. (2005) gave an experimental investigation and described the stabilization of expensive soil using fly ash and Raut et al. (2014) also gave experimentation for the stabilization of soil using fly ash and murrum.

## II. INDUSTRIAL WASTE MATERIALS AND ROAD CONSTRUCTION

There are many types of waste material found in India like industrial, building, household, agricultural etc. it includes fly ash, coal ash, stone quarry, plastics, glass, recycled aggregate, geo-naturals, fibers and polythene bags etc. Necessity of waste materials such as: scarcity of good quality aggregate/ soil for road construction. Production and accumulation of different waste materials, disposal and environmental problems and economy & gainful utilization is a very challenging task. Civilization also produces waste products. Disposal issue of the waste products is a challenge. Some of these materials are not biodegradable and often leads to waste disposal crisis and environmental pollution.

Roads are typically constructed from layers of compacted materials, and generally its strength decreases downwards. For conventional materials, a number of tests are conducted and their acceptability is decided based on the test results and the specifications. This ensures the desirable level of performance of the chosen material, in terms of its permeability, volume stability, strength, hardness, toughness, fatigue, durability, shape, viscosity, specific gravity, purity, safety, and temperature susceptibility etc., whichever are applicable. There are a large number tests suggested by various guidelines/ specifications; presently the performance based tests are being emphasized, rather than the tests which estimate the individual physical properties.

Industrial wastes from thermal power stations are fly ash, bottom ash and pond ash; from steel plants are blast furnace slag, granulated blast furnace slag and steel slag. Thermal power plant is major role in power generating and in Indian scenario fly ash used of coal with high ash content. Fly ash is one of the residues created during the combustion process and comprises the fine particles that rise with flue gases. In the civil engineering and industrial sense the term “fly ash” generally refers to coal fly ash captured from coal-fired power plants (thermal power plant) which is by far the most predominant fly ash used in construction and industrial applications. Fly ash is a waste by-product material that must be disposed of or recycled. In the past fly ash produced from combustion was simply entrained in flue gases and released into the atmosphere which created environmental concerns that prompted regulation of U.S. emissions down to less than 1% of total fly ash produced. Fly ash can be used for construction of embankment and backfills, stabilistion of sub-grad and sub-base and rigid and semi-rigid pavement. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide ($SiO_2$) (both amorphous and crystalline) and calcium oxide (CaO), also known as Lime both being endemic ingredients in many coal-bearing rock strata, Iron (III) Oxide (FeO2), Aluminum Oxide (Al2O3). Depending on source coal may include one or more toxic chemicals in trace amounts: Arsenic, Beryllium, Boron, Cadmium, Chromium, Cobalt, Lead, Manganese, Mercury, Molybdenum, Selenium, Strontium, Thallium, and Vanadium.

Fly ash is environmentally safe material for road construction. Possesses many favorable properties of embankment and road construction like light weight, lesser pressure on sub-soil, higher shear strength, high permeability, non-plastic, coarser ashes have high CBR value, faster rate of consolidation and low compressibility. Fly ash for road embankment is ideally suitable as backfill material for urban/industrial areas and areas with weak sub-soils, higher shear strength leads to greater stability, design similar to earth embankment, side slop erosion need to be controlled by providing soil cover. Fly ash can be use in road construction as to stabilize soil sub-grade and sub-base/base course such as (like) mixing with soil reduces plasticity characteristic, pond ash and bottom ash can also be stabilize, addition of small percentage of lime or cement greatly improves strength, lime-fly ash mixture is better alternative moorum for construction of WBM/ WMM. Construction of semi rigid/rigid pavements like (such as) lime-fly ash concrete, fly ash admixed concrete pavements, roller compacted concrete, high performance concrete.

Cement kiln dust (CKD) is the finely divided dry alkaline particulate matter carried from a cement kiln by the exhaust gas, and captured by the kiln’s air pollution control system. In general, however, the composition of cement kiln dust is similar to that of cement and consists of calcium carbonate, calcite, silicate, potassium sulphate, calcium sulphate, aluminum oxide, iron oxide, potassium chloride, magnesium oxide, sodium sulphate, and potassium fluoride. Cement kiln dust has a chemical composition similar to that of cement; therefore, the primary value of cement kiln dust is its cementitious properties. Its alkalinity and particle size also provide value for a variety of beneficial use options. It is Can be used in soil stabilization because of its hardening property when exposed to moisture and Corrosion of metals (used in concrete roads) in contact because of significant alkali percentage. Cement kiln dust (CKD) is the finely divided dry alkaline particulate matter carried from a cement kiln by the exhaust gas, and captured by the kiln’s air pollution control system. In general, however, the composition of cement kiln dust is similar to that of cement and consists of calcium carbonate, calcite, silicate, potassium sulphate, calcium sulphate, aluminium oxide, iron oxide, potassium chloride, magnesium oxide, sodium sulphate, and potassium fluoride. Cement kiln dust has a chemical composition similar to that of cement; therefore, the primary value of cement kiln dust is its cementitious properties. Its alkalinity and particle size also provide value for a variety of beneficial use options. Cement kiln dust can be used to improve the properties of soil in situ,

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and as an activator in pozzolanic stabilised base mixtures. The adsorptive capacity and cementitious properties of cement kiln dust allow it to reduce the moisture content and increase the bearing capacity of the soft soil. Such as Cement kiln dust effectively improves soil strength and also reduces construction time and costs; When lime is used as a stabilizing agent, the soil must be remixed and compacted 48 hours after the lime is first applied; When cement kiln dust is used as a stabilising agent, the mixing and compacting of cement kiln dust are completed when it is initially applied or within 24 hours; and Cement kiln dust can be mixed with soil to modify plastic limits or moisture content to provide the desired stabilized properties.

Blast furnace slag is an industrial byproduct of iron produced in a blast furnace. It is similar properties of cement. It is used binding matrial in road constructions. This slag consists primarily of silicates and aluminosilicates of lime and other bases. Blast furnace slag is generated during the melting process in steel making operations. The slag is a fairly complex mass that is relatively inert. It is composed of metal oxides (produced as a result of the oxidation of the metal during the melting process), melted refractory, sand from recycled scrap castings, coke ash, and other materials. The physical form of the slag largely depends on the method of collection. Slag that is quenched in water will typically form gravel sized particles. Blast furnace slag has been beneficially used in a number of applications. The most significant factor that determines whether or not blast furnace slag is suitable for use is the particle size. Most of the blast furnace slag that has been used has either been generated as part of a wet quenching collection system, or if collected dry, has undergone some particle size reduction. Blast furnace slag has been used as a cementitious binder material in road construction. The properties of blast-furnace slag have been developed in France under the title gravel-slag to stabilize gravel and sands for sub-base and base construction. Gravel-slag is the most widely used road base material in France. The advantages of blast furnace slag are: significant lower capital requirements as compared to cement, can be used for making concrete mixes for use in road bases and composite pavements and the slag would be mixed in a locally based central mixing plant and provides a great potential for profitable use of this waste material and produces alternate binder to cement.

Steel slag is a byproduct of the steel-making process, contains fused mixtures of oxides and silicates primarily calcium, iron, un-slaked lime, and magnesium. Steel slag contains significant quantities of iron; its highly compressed void structure results in a very dense, hard material. Steel slag obtained as a waste product during production of steel making, Particle size varies from 80 mm to 300 microns. It compared to blast furnace slag, steel slag contains lower amount of silica, higher amounts of iron oxide and calcium oxide due to presence of free lime, steel slag should be weathered before using it in construction.

There are some limitation and general criteria of using industrial waste materials. Limitation: quality of waste is not controlled by manufacturers, characteristics of by-product vary in a wide range, road construction practice is accustomed to traditional materials of steady quality and specification of layer compaction of traditional materials is not suitable for waste materials. General criteria: the material should not have a poisonous effect, the material should be insoluble in water, the utilization should not have a pollution effect to the environments and free for organic matters.

## III. CONCLUSION

A waste material is not good for society and environments then produce the minimum waste produce society. A maximum use of waste materials may be applied to businesses, communities, industrial sectors, schools, homes and road constructions. Also the utilization of waste materials like solid waste, hazardous waste will protect the environment and lead to a much more productive, efficient, and sustainable future. The objective of road constructions and others structure is to contain the waste material in a manner that is protective to human health and the environment. On the basis of above discussion we also observed that Blast furnace slag can be used in soil stabilization due to its hardening property when exposed to moisture, Blast furnace slag provides a great potential for profitable 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 and/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 natural materials required for all construction activities.

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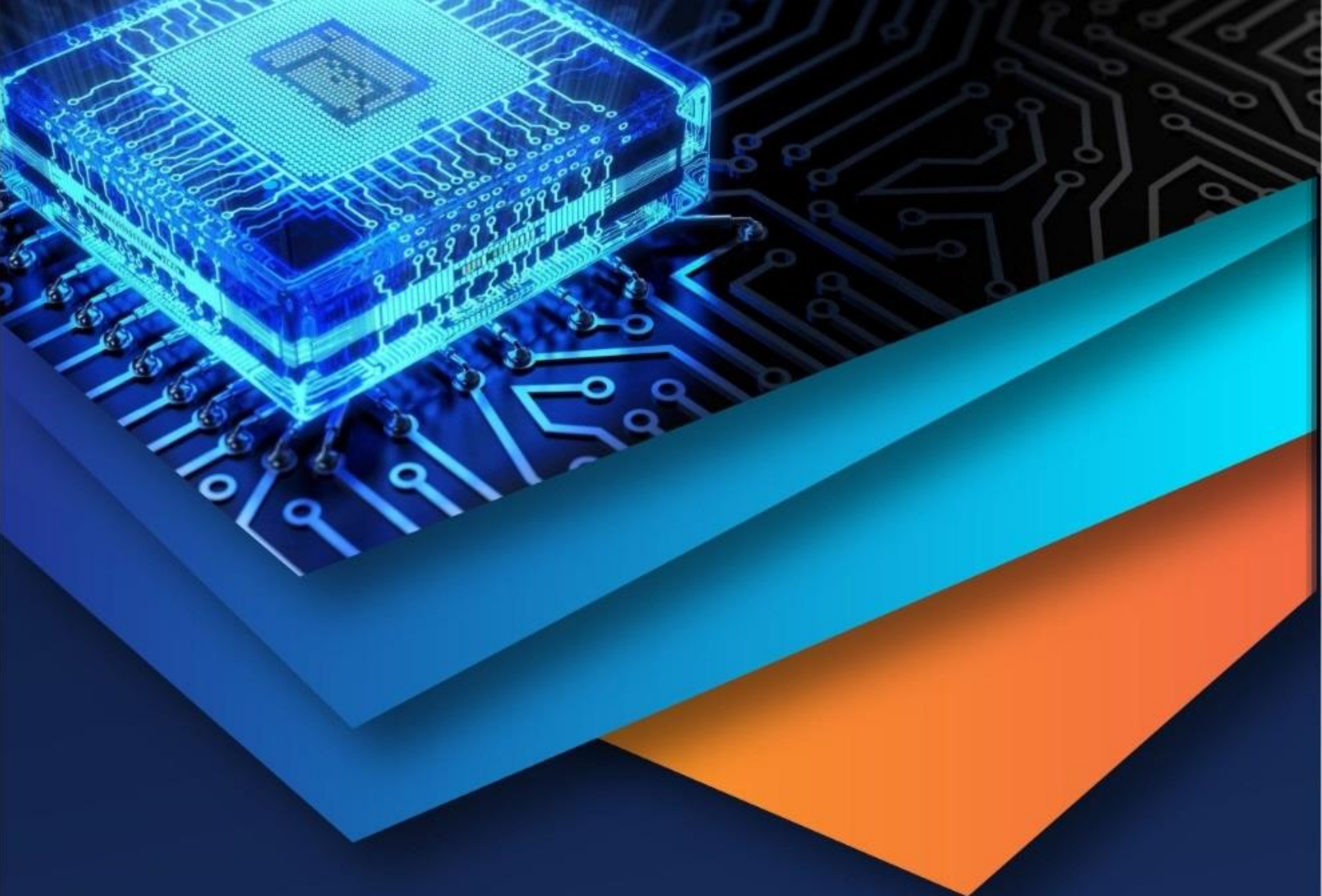


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