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EXPERIMENTAL STUDIES ON THE APPLICATION OF INDUSTRIAL WASTE AND BY-PRODUCTS FOR CONSTRUCTION OF HIGHWAY

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ABSTRACT

The estimation of roadway capacity is essential in planning, designing, and operation of highway facilities. Capacity and speed of road suffers a loss due to various factors such as geometric parameters, environmental parameters, city size factors, side friction factors etc. The environmental parameters include rainy conditions, fog, temperatures etc. The effect of friction factors can cause jam conditions in urban stretches, so need to be investigated and some regression equations need to be established between capacity and friction factor to know impact of friction factors. Better characteristics (geometrics, environmental etc.)of road may lead to higher capacity and higher speed at a certain flow.

The thesis aims at, to develop the speed flow relationship for the four lane urbanroad and to find out effect of friction factor on capacity and speed of road. Friction factor includes major effects such as pedestrian movements, parking & stoppingvehicles, exit/entry vehicles into traffic stream, unmotorized vehicles etc. At highside friction value there is significant difference between actual speed and those without friction i.e. very low friction from side. These capacity values arecompared with IRC: 106-1990. At low side friction value, capacity and speed does not affect much but at high side friction losses in capacity and speed are high. Therefore, the optimum dosage of steel fibers was determined to be 3 %.

Keywords:- geometric parameters, unmotorized vehicle, friction loses, steel fibre.

1. INTRODUCTION

This chapter is about an overview to the requirement for research investigations accomplished and presented in the chapters of this thesis.

Any developing country should strive to provide basic infrastructure for public use, as well as other vital agricultural and industrial advancements. (a) A few of the infrastructure facilities that the government will provide for public use include roads joining significant regions of the area either urban or rural, which may include expressways, NH, SH, major district roads and village roads (b) overpass, tunnels and bridges, (c) frivolous, zoo or animal parks, (d) water retaining bodies and controlling services, various irrigation heavy structures like canals, aqueducts, barrages-dams and many more.

Now, the focus is on the necessity of sustainable development to preserve environment for coming generations. By 2030, almost 60% of the world's population will reside in urban regions, according to UN statistics. Cities in the world consumes 60-80 percent of the energy and emits 75 percent of its carbon, although covering only 3 percent of the planet's surface. Urbanization puts more strain on the water and sewage systems as well as the quality of life.

The environment and public health Increased city density is expected to boost efficiency and technological innovation while simultaneously depleting natural resources and increasing energy usage. To achieve sustainable development, it is necessary to strike a balance between interrelated factors such as economic growth, social inclusion, and environmental conservation. These three key aspects benefit both individuals and society. The United Nations has established 17 global transformation objectives based on sustainable development. One of the UN's (URL-1) 2030 goals is to diminish cities' undesirable per capita environmental impact. Focusing on air quality as well as public and other waste management can help achieve this. The importance of long-term development is summarized in the following way (URL-2).

To Preserve Technological Assets

People nowadays just can envisage a life without the current modern technology that is employed in everyday life. Natural resources were not used as raw materials in the development of these technologies. Minerals and other auxiliary materials are needed in large quantities to make the items we use every day. It is possible to ensure that current technological requirements are addressed while also conserving resources for future generations through sustainable development.

To meet basic human requirements

As the world's population grows, basic necessities such as food, water, and shelter become increasingly important. These requirements rely on current infrastructure, which must be preserved for the future. If they are used indefinitely without regard for future needs, the expense and environmental depletion will be so great that meeting even the most basic necessities may become impossible.

Agricultural Demand

Increased population will almost probably require more farming activities. If the current unsustainable tilling, sowing, watering, spraying, and harvesting processes are continued, resources will run out sooner, making them very expensive. Crop rotation and efficient seeding procedures are two sustainable agriculture practices that can help achieve very high yields. It will also help to protect the soil's integrity by producing food for a bigger lot of persons.

Climate Change Prevention

Climate change is a critical concern in today's world. Climate change is said to have a negative impact on the world and, as a result, on life on the planet. It's also worth noting that human-caused climate change is attributed to the discharge of greenhouse gases into the sky. If no actions are made to control and eliminate these emissions, future peaceful living on Earth will be impossible. Sustainable development may be viewed of as an alternative that could give at least a partial answer or treatment for climate change control. Sustainable growth will necessitate a reduction in the usage of fuels that are both sustainable and emit greenhouse emissions. As the world's population grows, more people will require more energy, impacting the global climate even more.

Ensure financial security

Financially sustainable economies may be attained by taking global efforts toward sustainable development. By taking efforts to save resources, resource-poor economies will get more room to utilize the resources saved by adopting sustainable development, and so will be able to contribute to social and economic progress. This would also help to alleviate some of the problems with unemployment.

Biodiversity Preservation

It is stated that over-consumption and unsustainable development methods have harmful consequences on the biodiversity. For example, if unsustainable agricultural techniques that are being conducted are employed with relation to pesticides, this may have detrimental influence on the survival of bees and other pollinators. It's also worth noting that without bees, roughly 19 main food crops would decline, and over half of the world's food would be unavailable. Pollution from unsustainable development pollutes the oceans, which are home to a enormous amount of algal species. As a result, one of the most crucial initiatives we can take to conserve our ecology is to pursue sustainable growth.

SUSTAINABILITY DEVELOPMENT AND THE CIVIL ENGINEER

According to the American Society of Civil Engineers (ASCE), the civil engineering profession understands the realities of finite natural resources, as well as the urge for sustainable practices and social responsibility.

Need for fairness in resource usage (URL-3).

The ASCE supports the following strategies for achieving sustainable development.

- Encouraging a wide grasp of economic, environmental, political, social, and technological challenges and processes connected to long-term development;
- To increase the required skills, knowledge, and information for a long-term future;

APPROACHES TO SUSTAINABLE DEVELOPMENT USING INDUSTRIAL OFFSHOOT AND WASTES

It is common knowledge that manufacturers generate massive amounts of trash and industrial offshoot at the end of or throughout the production process. Only a tiny amount of these wastes and industrial offshoot are recycled or re-used, and they are commonly dumped on uninhabited land. Despite this, a large majority of them are rejected. Studies have been carried out to investigate if these wastes and industrial offshoot may be utilized as alternative materials. This is primarily to avoid environmental risks associated with land-filling.

2. LITERATURE REVIEW

This chapter summarizes research on the use of manufacturing wastes and industrial offshoot for constructions of roads, including, Red Mud (RM), Fly Ash (FA)and Waste Foundry Sand (WFS)

The impact of employing industrial effluents and industrial offshoot on soil strength metrics including CBR, UCC, and split tensile strength is investigated using literature. The goal of the literature review is to look at the environmental implications of utilizing industrial effluents and industrial offshoot in highway building.

APPLICATION OF INDUSTRIAL EFFLUENTS IN HIGHWAY BUILDING

Sen and Mishra (2010) investigated the potential for constructing village roads out of industrial effluents and byproducts such fly ash, blast furnace slag, cement kiln dust, discarded plastic baggage, WFS, collierysand and phospogypsum.

Schroeder (1994) identified many waste resources that have been utilised in the earlier or are now being used in succession for highway or embankment building. The author finds that highway building enterprises may efficiently utilise vast quantities of various resources.

Swamy and Das (2012) investigated the use of industrial effluents such fly ash, discarded glass, demolition debris, colliery refuse, slag, foundry sand, and kiln dirt.

Dawson et al. (1995) evaluated the feasibility of industrial offshoot produced in the United Kingdom for pavement building.

The ranking of various materials was done not only on the basis of structural performance, but also on the simplicity with which they may be utilized to make high-quality pavements. The results of the experiment showed that industrial offshoot may be used successfully as aggregate, binder, or both in the building of road foundation layers.

HIGHWAY CONSTRUCTION WITH WASTE FOUNDRY SAND

Kirk (1998) demonstrated that ferrous industry waste foundry sand can give engineering qualities acceptable for highway bank construction. He also mentioned that the MicrotoxTM bioassay examination would applied to screening the WFS to ensure that it does not pollute the environment. For the project, the Indiana Department of Transportation and Purdue University built a prototype embankment. For the study, WFS and ordinary soil material (as control embankments) were used to build embankments.

Geotechnical investigations reveal that WFS performs as well as natural sand does in terms of strength and deformation when used as a structural fill. But it must be emphasized such as WFS fill should not be thought of as without restrictions draining. According to the MicrotoxTM bioassay, the toxicity of WFS material was comparable to that of unprocessed sand. The author claims that the absence of decision-based scientific instruments, like as life-cycle or risk-based analytical techniques, is one of the obstacles to the effective reuse of WFS.

To evaluate the suitability of waste foundry sand (WFS) as a resource for road embankments, Mast & Fox (1998) carried out a significant field study. In their project, they looked at geotechnical parameters such deformation, strength, hydraulic properties, and ease of construction. Three distinct types of embankment sections—I clay borrow, II river sand, and III WFS—were the subject of their analysis. Their field demonstration experiment demonstrated that WFS may be effectively employed as bank fill elements for highway construction from a geotechnical standpoint.

The description of IITPAVE was provided by IRC 37 (2012). The laboratory-based strength values and IITPAVE were eventually used to establish sub-base thicknesses. IITPAVE may be used to test any combination of traffic and pavement layer composition.

FLY ASH IN HIGHWAY CONSTRUCTION

According to Dhawan et al., fly ash would be applied as a ‘sub-base’ and ‘sub-grade’ component (1994). The reaserchers investigated the properties of soil and coal ash combinations that may be used to construct roadways. Through laboratory research, the strength parameter of the combinations under study was determined.

Prabakar et al. (2004) conducted an experimental investigation on the effect of fly ash addition on soil shear strength. Authers noticed that the shear characteristics of the soil with a assured quantity of fly ash increased. Shear strength is observed to vary non-linearly with varied amounts of fly ash. It was too explored that increasing the amount of fly ash utilised reduced soil swelling. They came to the conclusion that fly ash combined with soil can be utilized as a roadway base material.

Lav & Lav (2014) investigated the impact of stabilisation on the resilient behaviour of fly ash to be utilised as a roadway pavement material by means of repetitive load indirect tensile and repetitive load triaxial tests. They stated that while using fly ash in the upper layers of the pavement, stability is critical.

They also stated that using fly ash in highway building did not pose a risk to the environment. The stress-strain behaviour of stabilised fly ash is nonlinear, according to their findings. They suggest that stabilised FA is a stress-dependent material that should be built in larger layers for highway construction than normal pavement layers.

Kolias et al. (2005) conducted experiments on the use of fly ash to stabilize clayey soil. They claimed that fly ash and cement might be utilised to even out clayey soil.

Wind-blown loess, according to Zia & Fox (2000), may be compacted on optimum water content and utilised as highway building material. They studied the engineering qualities of the loess-fly ash mixes through tests.

HIGHWAY CONSTRUCTION WITH RED MUD

Kalkan (2006) published the findings of an inquiry on red mud for practical use. It was looked at using red mud as a stabilizing material. This research is looking at the impact of red mud on soil stability. Experimental research was used to assess unconfined compressive strength, hydraulic conductivity, and swelling. Condensed clay specimen comprising red mud and cement–red mud additives have a high compressive strength, according to the researchers. They further claim that when compared to natural clay samples, the hydraulic conductivity and swelling percentage are lower.

Singh et al. in explored the manufacture of special cements with red mud sourced from a company HINDALCO Industries Limited, located in Renukoot, India. In their research, they looked at three different types of cement. On the cement characteristics, the impacts of composition, fire temperature, and time were investigated. The cements manufactured using lime, red mud , bauxite and gypsum have strengths same to or better than standard Portland cement, according to test findings (OPC). Those made with lime, red clay, and fly ash, however, lacked adequate strength.

MATERIALS FOR SOIL STABILIZATION

Little (1995) published a guide on the use of lime for the stabilization of highway and airfield base, sub-base, and subgrades. (a) The processes of lime-soil interaction, (b) mixture proportioning, (c) The engineering benefits of lime stabilising soils and aggregates, (d) design of pavement thickness, (e) building and quality regulator, and (f) lifespan budget are all covered in the handbook.

Little and Nair (2009) published a study on the use of classic calcium-based stabilizers including Portland cement, lime, and fly ash to treat soil. The interactions that occur between the soil and the stabilizers and soil are described and compared in their report. The study also provides stability mechanisms.

CLUSTER ANALYSIS

Performing a large number of experimental investigations while adjusting various conceivable factors or characteristics of the specimen under examination might yield a large amount of experimental data. The experiment results must be evaluated in order to draw inferences and draw conclusions.

Cluster analysis is one approach that may be used to help with this sorting issue. Normally, while evaluating the findings of studies, the influence of one or more factors on another variable is investigated. Also, based on the interpretation of the experimental results, the order of the effect of several factors on a given variable may have to be determined.

INFERENCES FROM THE LITERATURE STUDY

According to the literature review, there is a lot of potential for employing industrialized wastes and industrial offshoot in road building. Fly ash, Surplus foundry sand and red mud have been shown to increase the production merits of soil, suggesting that they might be used as an alternative to new materials. Few studies too stated that the utilization of stabilizing elements either cement or lime is required in order to achieve higher geotechnical strength characteristics.

In terms of our own nation, India, much more is required in terms of new highway development and the maintenance of existing damaged roadways. As a result, using industrial offshoot and trash for highway building might provide an outstanding area for applying them instead of dumping on unoccupied land, harming the environment. As a result of the usage of industrial offshoot and trash, sustainable development will be achieved.

Research studies on the use of industrial effluents and industrial offshoot slike fly ash, waste foundry sand; waste rubber, waste plastics, colliery spoils, red mud, and others have been published in the literature.

MOTIVATION FOR THE PRESENT STUDY

India is a developing country. A huge number of industries that have been established or are being established will discharge large volumes of wastes and industrial offshoot into waste land or elsewhere. In addition, to satisfy transportation needs, damaged roadways in villages and distant locations must be repaired, and new highways must be built.

3. THE STUDY'S OBJECTIVE

The goal of this experiment is to establish the engineering qualities of a mixture of two or more industrial effluents and industrial offshoot with stabilizing ingredients, such as lime or cement, and decide if they are suitable for use as highway building material.

4. OPPORTUNITY OF THE STUDY

The goal of current experiment is to create the engineering qualities of a mixture of two or more industrial effluents and industrial offshoot with one of the stabilizing ingredients, such as lime or cement, and decide if they are suitable for use as highway building material.

5. CONCLUSIONS

In this section, this part summarizes the conclusions reached based on the findings of the experimental investigations, followed by the conclusions reached based on the findings of the analytical studies.

- The change of the CBR value in relation to the percent of WFS employed in the mixture is non-linear in general.
- There is an ideal percent of WFS for both the stabilizing elements utilized in this study, such as cement and lime, that results in a greater CBR value of the combination.

- Adding 10% red mud to the combination reduced the CBR value for virtually all of the WFS percent adjustments studied.
- It was discovered that using WFS at 70% of the time resulted in increased strength (CBR value)
- The usage of 5.5% red mud at the optimal WFS resulted in a higher CBR value.
- 20 per cent The optimal mixture among the mixture proportions investigated for the experimental investigation is 7. 20% use of fly ash, 5% use of red mud, and 70% use of WFS.
- The CBR value of the combination is reduced by more than 20% when fly ash is used
- Utilizing cement as a stabilizing ingredient improved the CBR value of the combination by about 60% as compared to using lime as a stabilising agent. Nonetheless, the percentage of red mud in the combination has an impact on the rise in strength.
- There are several varieties Variations in the CBR value of the mixture as a result of changing the % use of red mud are largely due to changes in fly ash.
- The presence of varied percentages of red mud evaluated in this study has a considerably smaller influence on the CBR value for different WFS to fly ash ratios in general. Both stabilizing chemicals have a less influence on the CBR value when varying amounts of red mud are used.
- When the ratio of WFS to fly ash % is less than 5, it has the most impact on the mixture's strength.

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