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A Review Study on Partial Use of Building Demolition Waste as Lime Treated Base Course in Butiminous Road

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Abstract - *The main aim of the study is to use the demolition building waste as lime treated base in bituminous road. In this study lime is added to the demolished building waste to make it lime treated base material. The dry density, specific gravity, abrasion, impact value and crushing value of material is determined in demolished waste aggregate and after treating with lime, California bearing ratio and resilient modulus of base course is determined. Base course is highest quality structural materials having strengths of nearly 100 percent CBR so in this study, lime is being used to increase the strength of building demolition waste aggregate so as to gain the same strength as natural aggregate which also reduce the thickness of base layer. Here in this study, modulus of resilient of base course is also determined to know the strength of base course over the rapid traffic load.*

***Key Words*: Building demolition waste, Resilient Modulus, CBR Value, Natural aggregate, Demolition waste aggregate**

1. INTRODUCTION

It is found that in India nearly 50% of Building Demolition waste is being recycled, while the remaining is mostly land filled. In India its common practice for large Building Demolition projects to pile waste in the road, resulting in traffic congestion. With the rapid development of the construction industry and the accelerated pace of urbanization, large numbers of old buildings are being demolished in urban areas, resulting in extremely significant amounts of C&D waste. Demolition wastes are heterogeneous mixtures of building materials such as aggregate, concrete, wood, metal, insulation, and glass that are usually contaminated with paints, fasteners, adhesives, insulation and dirt.

The composition and quantities of demolition wastes depend on the type of structure being demolished, the types of building materials used, and the age of structure being demolished The quantity of demolition wastes resulting from industrial structures is estimated to be from 1.5 to 2.0 ton/m^2 of the total demolished area the quantity of demolition wastes from residential buildings is estimated to be 1.3 to 1.6 ton/m^2 of the ground floor area of the structure grinding of demolition wastes has been attempted to reduce the total waste volume while the resulting powdered wastes could be landfilled To obtain a material of high quality the demolition waste is sieved first, to remove the fines. The fine material rather to disposed of, it can be utilised, both from an economic and environmental point of view.

1.1 Lime

Lime in the form of quicklime (calcium oxide – CaO), hydrated lime (calcium hydroxide – $Ca[OH]_2$), or lime slurry can be used to treat soils. Quicklime is manufactured by chemically transforming calcium carbonate (limestone – $CaCO_3$) into calcium oxide. Hydrated lime is created when quicklime chemically reacts with water. It is hydrated lime that reacts with clay particles and permanently transforms them into a strong cementitious matrix. Most lime used for soil treatment is "high calcium" lime, which contains no more than 5 percent magnesium oxide or hydroxide. On some occasions, however, "dolomitic" lime is used. Dolomitic lime contains 35 to 46 percent magnesium oxide or hydroxide. Dolomitic lime can perform well in soil stabilization, although the magnesium fraction reacts more slowly than the calcium fraction. Here "lime" means quicklime or hydrated lime.

Lime can permanently stabilize submarginal base materials (such as clay-gravel, "dirty" gravels, limestones) that contain at least 50 percent coarse material retained on a 4.75 screen. Base stabilization is used for new road construction and reconstruction of worn-out roads, and generally requires adding 2 to 4 percent lime by weight of the dry soil. In-situ "road mixing" is most commonly used for base stabilization, although off-site "central mixing" can also be used. Lime is also used to improve the properties of aggregate mixtures in "full depth recycling." Small percentages of lime (generally 1 to 2 percent) can be added to aggregate base courses containing excessive fines, often transforming marginal or non-specification materials into superior bases. The recarbonation of the lime will often cement the fines into larger particles that contribute to the structural strength of the aggregate base.

Different types of limes are used for building construction. It is not generally found in the free state. Lime is a product which is obtained by burning lime stone, a raw material, found in lime stone hills or lime stone boulders in the beds of old river, kankar found below ground level, or shells of sea animals. Some of them are;

Quick Lime: It is also known as caustic lime. It is obtained by calcination (i.e. heating to redness) of comparatively pure lime stone. It is amorphous in nature, highly caustic and possesses great affinity to moisture.

Slaked Lime: It is also known as hydrate of lime. It is obtained by slaking (i.e. chemical combination of quick lime with water) of quick lime. It is ordinary pure lime, in white powder form, available in market. It has got the tendency of absorbing carbonic acid from the atmosphere in presence of water.

Hydraulic Lime: It is also known as water lime. This lime contains clay and some amount of ferrous oxide. It sets under water and hence also known as water lime.

2. Literature review

A.J. Puppala et al. (1996) The percent increase in unconfined compression strength with respect to lime treatment is higher at wet-of-optimum moisture content levels than at dry-of-optimum moisture content levels. This indicates the importance of the presence of a greater moisture content for better stabilization. Also, as expected, the curing period resulted in an increase in unconfined compression strength. The accumulated plastic strain of a lime-treated soil is less than that of an untreated soil at a particular confining and deviatoric stress. This indicates that the lime treatment method can decrease rutting or plastic deformation. Also, a 20 to 50 percent increase in the magnitudes of the resilient modulus value is obtained with the lime treatment at most confining pressures of the first three moisture content levels.

Sobhan et al. (1999) Investigated the flexural fatigue behavior of a stabilized fiber-reinforced pavement base course material that was composed largely of C&D waste with small amounts of Portland cement and fly ash; this study found that the performance of the composite material was satisfactory as a base material

Nataatmadja and Tan (2001) Studied the capacity of the resilient response of a subbase made from four types of recycled aggregate with a view to verifying whether its strength was comparable to that of a subbase made of natural aggregate

Poon, C. S., and Chan, D. (2006) Studied the use of recycled concrete aggregate and crushed clay brick in unbound subbase materials in Hong Kong. The results of their research indicated that the use of 100% recycled concrete aggregate increased the optimum moisture content and decreased the maximum dry density of the subbase materials compared to the use of aggregate composed of natural subbase materials.

Arvind Kumar et al.(2007) had conducted an experimental program to study the effects of fiber inclusions and lime stabilization on geotechnical characteristics of fly ash-soil mixtures. From the results it was observed that the expansive soil can be successfully stabilized by the combined action of fibers, lime and fly ash

Zha et al.(2008) Studied the potential use and the effectiveness of stabilization of expansive soils using fly ash and fly ash-lime as admixtures. The test results showed that the plasticity index, activity, free swell, swell potential, swelling pressure and axial shrinkage percent decreased with an increase in fly ash-lime content

Rao et al.(2008) carried out a study on the performance of lime stabilized fly ash cushion and found that it was quite effective in arresting volume changes in expansive soils. A fly ash cushion, stabilized with 10% lime and with thickness equal to half that of the active zone in an expansive soil bed, reduces heave by about 68% initially. With subsequent cycles of swelling and shrinkage the percentage reduction in swelling is as much as 99.2%.

Rama Rao et al.(2008) using cement-stabilized fly ash as a cushioning material, on the expansive soil bed. The results showed that it was quite effective in arresting heave also fly ash cushion, stabilized with 10% cement with thickness equal to that of the expansive soil bed reduces heave by about 75% in the first instance and at the end of fourth cycle of swelling, the reduction in the amount of heave is as high as 99.1%.

Chong W.K (2009) presents an industry framework for the continuous development of CDW reuse and recycling. This paper underlines that current incentives provided for the additional work that contractors must perform when CDW is used are clearly insufficient. Furthermore, designers lack the knowledge of what actually can be recycled in the region. Nor are they truly aware of how to reduce the cost of recycling.

M. A. Kumar et al. (2009) The load carrying capacity of the flexible pavement system is significantly increased for lime-cement stabilized fly ash subbase stretch with respect to the fly ash subbase stretch, on sand subgrade and on expansive subgrade. The total deformation values of the flexible pavement system are decreased considerably for the lime-cement stabilized fly ash subbase stretch, when compared with fly ash subbase stretch both on sand subgrade and expansive subgrade respectively. It is observed that the total deformation at 500 kPa is decreased by 52.73% for treated lime-cement fly ash subbase when compared to untreated fly ash subbase laid on sand subgrade. For expansive soil subgrade the total deformation at 500 kPa is decreased by 65.07% for treated lime-cement fly ash subbase as compared to untreated fly ash subbase stretch in the laboratory.

Lu et al. (2011) investigated that one of the critical steps to make a sound waste management plan is to estimate quantities of C&D waste based on waste generation rates

(WGR). Owing to its importance, the investigation of WGR has long been attractive to researchers and construction practitioners. Lu et al. examined WGR in Shenzhen city of South China through conducting on-site waste sorting and weighing in four construction projects.

Khoury et al. (2013) Studied Stabilisers widely used by engineers include traditional stabilisers, such as cement, lime and fly-ash, lime kiln dust and cement kiln dust. The improvements in the engineering properties of problematic soils were observed in terms of reduction in PI and swelling potential, and an increase in performance-related indicators, such as unconfined compressive strength (UCS), resilient modulus, elastic modulus and California bearing ratio.

Salahudeen et al. (2014) Studied the increase in CBR values could be due to the presence of adequate amounts of calcium required for the formation of calcium silicate hydrate (CSH) and calcium aluminate hydrate (CAH), which are the major compounds responsible for strength gain in soil stabilization.

J. Peterfalvi et al. (2015) A test road was built to examine the effects of lime stabilized soil as subgrade. As expected, the applied lime increased the bearing capacity of the original cohesive soil. When designing a pavement with lime stabilized medium clay subgrade, it can be taken into account with a 500 MPa layer modulus. Doing so, the required bearing capacity can be reached with smaller amount of additional building materials. Therefore, transportation and construction costs as well as environmental impacts can be reduced. In order to get satisfactory performance from the pavements built on cohesive soil, 25–35 cm of lime stabilized subgrade should be designed to support them. For low traffic roads, 35 cm of stabilized local soil with a thin (15 cm) crushed stone surfacing could be enough to provide traffic ability. 25–35 cm thickness can be constructed in one stage of mixing if the constructing machine is appropriate.

Pundir V.S et al. (2015) with addition of stabilizers i.e. cement and lime, the Indian Bearing Ratio (I.B.R) increases upto a certain limit but after that the I.B.R. value decreases even on further addition of stabilizers.

As in the case of cement stabilization, the I.B.R. increases up till addition of 8% cement content but on further increase in cement content i.e. 12% there is hardly any increase in value of I.B.R. and on further addition of cement content i.e. 15%, the value of I.B.R. reduces drastically. Similarly, in the case of lime stabilization, the I.B.R. value first increases upto a certain limit and after that the value decreases with further addition of lime.

Chowdhury et al. (2016) reported that Dhaka alone produces approximately 3000 tons/day of solid waste including construction waste. However, reliable estimation or empirical model for estimating C&D waste in Bangladesh is still unavailable. Hence, the policies to address C&D waste organization in Bangladesh are inadequate. Due to the absence of recycling facilities and law enforcement, most of these wastes end up being dumped in unauthorized places or landfills in cities of Bangladesh, which eventually causes a high negative impact on the environment and a significant loss to the economy. The C&D waste is, therefore, becoming a public concern in the country.

Zheng et al. (2017) if properly managed, this C&D waste can be a valuable resource for the country. The waste consists of some inert type solid waste including metal, mortar, concrete, brick, plastic, timber, ceramic and glass; approximately 80% of which can be reused. This indicates a high economic value of C&D waste

Jin et al. (2017) Observed the possible application of this recycled material in "green" concrete masonry blocks. This "green" building materials are still limited in their utilizations, such as in non-load bearing partition walls and ornamental urban elements.

Pereira R. S. et al.(2018) addition of lime modified the mechanical behavior of the local soil, increasing its strength and load-bearing capacity - characteristics desirable for road construction; compaction effort and curing time provided different mechanical responses of the soil-lime mixture, and at the 28-day curing time this mixture can be considered for application as subbase material of flexible road pavements.

Dhar, S. et al.(2019) The CBR values treated with optimum lime meet the requirement of subbase materials for low traffic rural roads, as per IRC-51. The total cost saving found to be 43.47% and 24.77% respectively after stabilizing soil1 and Soil2 subgrade soil with optimum lime. Thus by reducing the overall pavement thickness, the total cost of pavement construction can be reduced significantly

Lu z et al. (2020) the influence of moisture content on the dynamic resilient modulus of lime-treated expansive soil is most significant. With the increase of moisture content, the dynamic resilient modulus decreases significantly. An increase of 2% in the moisture content will contribute to a decrease of about 25% in the dynamic resilient modulus.

3. CONCLUSIONS

As it has been observed that demolished building waste has been used in roads as land filled without treating the concrete materials and the dust particle. In this paper it is analyzed that the demolishing building waste can be recycled and can be use as a base course material if used with lime. Hence using lime will help to gain strength and CBR value will be as similar to the natural aggregate or may be increase which will allow to reduce the thickness of base layer which will help in economic as well as environmental point of view.

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