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Application of Tire chips in reinforcement of soil: A review

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Abstract : Weak or soft soil is considered unsafe for construction of engineering structures. To bring about improvement in such soil, ground improvement techniques are utilised commonly in these days in which the engineer forces the ground to adopt the project's requirements, by altering natural state of the soil, instead of having to alter the design in response to ground natural limitation. In this present study, shredded rubber from waste has been chosen as the reinforcement material for soil improvement. The study mainly focuses on the utilisation of tyre chips to increase the strength behaviour of soil. Utilisation of tire chips as a soil reinforcing material has increased abruptly with its application being used in various structures such as embankments, pavement, retaining walls, landfill, subgrade in roads etc. The growing markets of recycled tires to be used in construction give us a good idea about the potential that can be explored in this field. Its light weight and durability properties make it ideal for the reinforcing material. Use of tire chips has an advantage of being available at a very low price as well as with it comes the utilisation of the waste product. Many researchers conducted experiments with soil reinforced with tire chips and the result shows it as a viable alternative in the form of reinforcing material or to gravel in the form of aggregate. This paper reviews the various applications provided by the tire chips reinforced soil on construction works.

Keyword: ***waste, tire chips***

1. INTRODUCTION

Waste material has been defined as any type of material by product of human and industrial activity that has no lasting value. The growing quantities and types of waste materials, shortage of landfill spaces, and lack of natural earth materials highlight the urgency of finding innovative ways of recycling and reusing waste material additionally; recycling and subsequent reuse of waste materials can reduce the demand for natural resources, which can ultimately lead to a more sustainable environment. A sustainable construction has become a great concern over construction practice at the expense of the future of our planet. The possible use of scrap tyres is in the form of tyre chips and crumb rubber aggregate. With more than 250 million tires discarded annually (approximately one tire per person), and that number showing no signs of declining, the scrap tire market continues to search for new uses of old tires. Waste tire chips are basically tyre product and are used as substitute or replacement for aggregates used in construction structures or as reinforcing material in ground or soil improvement. As with other items made from rubber or plastic, old tires have the potential to be an environmental hazard. Historically, waste tires took up space in landfills or breeding grounds for mosquitoes and rodents when stockpiled or illegally dumped. In 1985 when Minnesota enacted the first state law for managing scrap tires. The three areas that states have generally focussed on are programme management for scrap tires, creation of market development programs, and stockpile abatement. The shredded tires or recycled tires can be used for construction purposes. There is a Patent on a rubber-reinforced concrete, and research, conducted on concrete with tyre chips and rubber aggregate. Another development is in the use of finely ground scrap or rubber in asphalt.

Image of tyres and its waste

2. SOIL REINFORCEMENT

Reinforcement is an effective and reliable technique for increasing strength and stability of soils. In general soil reinforcements can be classified into two major categories (by their stiffness): (1) ideally inextensible and (2) ideally extensible inclusions. The former includes high modulus metal strips and bars, while the latter includes relatively low modulus natural and synthetic fibers, plant roots and polymer fabric and shredded tyre chips. Various studies have demonstrated the feasibility of using shredded waste

tyres to reinforce soils. Greater strenght and ductility, increase in shear resistance to displacement depending upon the shred content and size, was the result of various tests conducted on such soils reinforced with tire chips which has proven its suitability and positive application usage.

3. SUITABILITY OF TIRE CHIPS

The primary objective of the research described herein is to assess the pertinent engineering properties for reusing shredded scrap tires as a construction material for light-weight fill material in highway construction, for drainage material in highway and landfill construction, and for other similar applications. Due to the lightweight and high capacity of rubber in damping energy, it can be used for seismic forces reduction and absorption of earthquake vibration. Reuse of scrap tires would not only provide a means of disposing of them but would also help solve difficult economic and technical problems. This paper presents the characteristics of shredded scrap tires and their engineering properties and behaviour alone or when mixed with soils. The properties considered include compaction, compressibility, strength and deformability, and hydraulic conductivity. Studies involving Bearing capacity of model footing on sand reinforced with shredded tire as done by some researchers has shown result using waste tires in civil applications may be feasible to consume the scrap tires. Shredded rubber mixed with soil acts as reinforcing materials beneath the footing, the performance of rubber-reinforced soil increases in presence of soil, bearing capacity of rubber-reinforced bed obtained was better as compared ot unreinforced bed and findings lead to overall saving in soil material costs and recycling of tires waste. Similar as such various other researchers have obtained succesfull results in terms of tire chips being used as a reinforcing material for soil reinforcement and as such various markets are being set up all over the world for sale of such waste shredded tire chips. Ofcourse properties such as size of tire chips materials plays is role as according to the site construction in which it is being used.

4. APPLICATION OF TIRE CHIPS

Scrap tire are a high-profile waste material for which several beneficial uses have been proposed and put into practice. One approach consists of shredding the tires into small pieces that are often referred to as tire shreds or tire chips, depending on their sizes . Tire chips have been used in a variety of applications because of their unique engineering properties. Its combination with soil material has proven beneficial in many application process. With the addition of geocell material the ability of soil reinforced with tirechips has wide range of scope in future studies.

4.1 USE OF TIRE CHIPS IN LIGHTWEIGHT BACKFILL

A large number of used tires are disposed of every year. A more productive, enviromentally desirable use of these tires would be the construction of backfill. Such fills are lighter than traditional fills. Additionally the present study shows that the strength of these materials are usually adequate for such application. The use of tire chips or mixtures of tire chips and sand (i.e. rubber–sand) as lightweight fill could significantly minimize the waste tire disposal problem that currently exists. Geosynthetics may be placed within tire chips or tire chip–sand backfills of earth structures to increase lateral confinement of the system, improve the shear modulus due to vertical confinement, and spread the vertical stresses due to tensioned membrane. many of such studies as done by J.H. Lee, R. Salgado, A. Bernal etc has repeatedly experimented and shown the suitability of such material as a Backfill material.

The backfill areas of concrete culverts constructed in roads have been subjected to differential settlement due to poorly compacted soils. In order to redue the dynamic earth pressure studies with the use of tire chips was carried out and found out that recycled tire chips are more efficient in reducing the dynamic earth pressure because of its relatively high damping ratio and low stiffness values as compared to the local backfil filling method.

4.2 USE OF TIRE CHIPS AS LEACHATE DRAINAGE MATERIAL

As shown by missisipi department of enviromental quality tire chips has been utilised in the design and construction of leachate collection systems at municipal solid waste landfills. In the above design a 30cm depth of leachate is maintained over the flexible membrane liner. The benefits that was obtained was a greater volume of leachate was collected and removed, less maintainance required on pumps, filters and handling system due to reduced amount of sediment entering the leachate collection system. The hydaulic conductivity of the tire chips with the underlying sand layer is the main mechanism that this design makes use of. Size of tire chips plays an importent role in this application.

4.3 INCREASE IN BEARING CAPACITY OF SAND REINFORCED WITH TIE CHIPS

With the better understanding of the behavior of rubber–soil mixture by various reseachers it has been found out that the bearing capacity of footing reinforced with tire chips was increased. The study investigated the feasibility of using rubber shreds, randomly distributed into the soil, as soil reinforcement beneath the footing. The results show that the efficiency of rubber reinforcement was increased by addition of rubber content with parameters such as thickness of shreds and the layer being considered within certain limits. The findings strongly suggest the use of rubber shreds obtained from non-reusable tires as a viable alternative way for improving the soil behavior, particularly when environmental interest is considered.

4.4 RECYCLED WASTE TIRE RUBBER IN ASPHALT MIXTURES AND CEMENT CONCRETE

Over the years, recycling waste tires into civil engineering applications, especially into asphalt paving mixtures and portland cement concrete, has been gaining more and more interests. The use of crumb rubber in asphalt paving mixture has long been proven successful due to good compatibility and interaction between rubber particles and asphalt binder, leading to various improved properties and performance of asphalt mixtures. The rubberized asphalt mixtures also have shown good compatibility with two widely used sustainability technologies in asphalt paving industry – reclaimed asphalt pavement (RAP) and warm-mix asphalt (WMA). In comparison with its use in asphalt paving mixtures, recycling of waste rubber in Portland cement concrete has not been so successful. Various methods have been proposed to overcome the barriers to improve the performance of rubberized portland cement concrete, some of which have shown to be promising. Still more research efforts have to be made to significantly improve the properties and performance of rubber modified concrete and to increase its use in structural engineering.

4.5 USE IN RETAINING WALL BACKFILL UNDER EARTHQUAKE LOADING

Model test results indicate that the presence of tyre chips (either as cushion or as reinforcing material) could substantially reduce the earthquake-induced permanent displacement of structures. Tire chips usage has also been effective in terms of use in retaining wall backfill subjective to earthquake effect. TDA (tire derived aggregate) is the main material used in this design. Tire derived Aggregate (TDA) is a recycled lightweight construction material produced by cutting waste tires into 25–305 mm pieces.For the past two decades, TDA has been used in various civil engineering applications including subgrade and embankment fill, retaining wall and bridge abutment backfill, subgrade insulation to limit frost penetration, and lateral edge drains.

5. CONCLUSION

The increasing number of waste tires has posed a serious threat to environmental protection and public health efforts in recent years. Various applications as given above have suitably reduced the negative effects of waste tyres that is being deposited evry year. Its scope in properties, suitability, applications in various construction works and future prospectives have risen considerably in recent years. Various researchers have already started studies related to its application and usage as given above. Not only its enviromental damage gets reduced but also its usage in construction works creates a huge beneficial effect for future.

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