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Comparative Study of Waste Nylon and sand Interlocks and Concrete Interlocks

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ABSTRACT: Nylon waste is an unspoken threat to the environment and its dumping leads to harmful effects on the environment, since waste nylon has low biodegradability. The research is aimed at recycling wastes Nylon as binding groundmass in place of cement in the production of interlocks. This will go a long way in solve part of our environmental and ecological problems resulting from haphazard dumping of waste Nylon, In this study, melted waste nylon and sand was used as a binding agent in complete substitute of cement with sharp sand in interlocks production. Test on compressive strength and Abrasion Resistance were carried out on two different types of interlocks (waste nylon and sand interlock) ratio 3:7 was used for waste Nylon and sand interlock. The result shows that, the interlocks produced with waste Nylon and sand has higher compressive strength (stronger) than that of concrete and abrasion Resistance. Base on the test, results, of findings and conclusion, the following recommendations were made: Government should invest in using waste nylon to produce interlocks and create more awareness of this innovation to the community; this could serve as waste decrease and employment chance. The study has clearly established that waste Nylon interlocks are better alternative to normal concrete interlocks.

Key words: Interlock, waste Nylon, compressive strength, Abrasion, Concrete.

I. INTRODUCTION

Interlock is versatile, aesthetically attractive, functional, and cost effective and requires little or no maintenance if correctly manufactured and lay, Natural resources are depleting worldwide at the same time the generated wastes nylon from the industry and residential area are raising largely. The sustainable development for construction involves the use of Nonconventional and innovative materials, and recycling of waste materials in order to reimburse the lack of natural resources and to find alternative ways conserving the environment. Waste is defined as any unavoidable material resulting from domestic activity or industrial operation for which there is no economic demand and which must be disposed of (Strength 2018). The use of nylon appears to have come to stay in Nigeria, as some people prefer it to other products, when it comes to wrapping sundry items. For many, the nylon is the go-to disposable container for preserving foods and other perishable items in the freezer. Nylon is one of the daily increasing useful as well as a hazardous material. At the time of need, Nylon is found to be very useful but after its use, it is simply thrown away, creating all kinds of hazards. Plastic is non-biodegradable that remains as a hazardous material for more than centuries. While other items, such as paper and leaves decompose with time and even help to improve the soil quality, nylon is not biodegradable, which means it tends to retain its nature and stays the same, decades after use. So, heaps of nylon thrown away 20, 30 years ago are still lying buried intact in various dumpsites and other places. Surely this cannot be favorable to the environment. According to (Ezeokoli, 2019) Nylon and such others are also included in the category of non-biodegradables. These substances, she noted, can stay intact for as long as 100 years, as they don’t easily break down.

The quantity of nylon waste generated is very high in amount. Very less work has been done on the interlock made from the waste nylon. Objectives of this research are:

1 To recycle waste Nylon
2 To produce interlock from the used west Nylon and sand
3 To determine the compressive strengths of Interlocks produced with Waste Nylon and sand and concrete Interlocks.
4 To determine the abrasion resistance of both concrete Interlocks and Interlocks produce with Waste Nylon and sand.

Dash, (2010) defines Nylon as a generic designation for a family of synthetic polymers,

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based on aliphatic or semi-aromatic polyamides. Nylon is a thermoplastic silky material that can be melt-processed into fibers, films or shapes it is estimated that it takes between 30 to 40 years for a nylon fabric to decompose. This reduces water infiltration into the soil, land degradation, and can also make landfill site to fill up quickly.

Physical properties of Nylon

1 Nylon has a repeat unit with molecular weight of is 226.32g/m (cm)
2 Nylon has long molecular chains resulting in more hydrogen bonds, creating chemical springs and making it very resilient
3 Nylon is an amorphous solid so it has a large elastic property and is slightly soluble in boiling water
4 Nylon is very stable in nature
5 Nylon is very difficult to dye once it is dyed it has a high color fustiness and is less susceptible of fading

Advantages of Nylon

1 Nylon per sues excellent abrasion resistance and a high melting point.
2 Nylon has high tensile strength and exhibits only half of shrinkage in steam
3 It also provides a very good resistance to photo degradation

Concrete

Concrete is a composite man-made material and is the most widely used building materials in the construction industry. It consists of mixture of binding materials (lime or cement), fine aggregate and coarse aggregate, water and admixture to produce concrete with special properties (Mathye, 2017). Concrete can be used in construction because of its durability and can be moulded into any shape and it is a versatile construction material it is plastic and malleable when newly mixed yet strong and durable when hardened. These qualities explain why concrete can be used to build bridges, highways, houses and dams (Bustillo, 2021).

Aggregate

Aggregate was originally viewed as an infant material dispersed, throughout the cement paste largely for economic reason (Bustillo, 2021). Aggregate was defined as “the relatively invent filler materials in a Portland cement concrete.” Aggregate are used in concrete to increase its volume, increase strength and durability, reduce creep, reduce overall cost, impart and thermal properties and impart density, increase chemical resistance (Ezeokoli, 2019)

Types of Aggregates

a Fine aggregate (Sand)
b Course Aggregate

Fine aggregate (Sand)

Sand is essentially quartz whereas clay is made of many other chemically active minerals like illite, kaolinite, etc. sand between 4.75mm (about 5mm) and 0.150mm in size is called as fine aggregate. It is used for making concrete mortars and plasters. It is also used for filling under floor basement. Otherwise, transport expense will be major part of the cost of the sand. Natural sand is available from local river beds or pit (Omopariola, 2020). According to the size fine aggregate may be described as coarse sand, medium sand, and fine sand. I.S specification classify the fine aggregate into four types according to its grading (size distribution) as fine aggregate of grading zone 1 to zone 1V the four grading zones becomes progressively finer from zone 1 to grading zone 1V. 90% to 100% of the fine aggregate passes 4.75mm: sieve and to 15% micron IS: sieve depending upon its grading zone.

Mechanical properties

1. Bond strength of concrete. The resistance develops to shear particles from the hardened cement paste3 is called bond strength of aggregate. Bond is partly due to the interlocking of the aggregate and the paste owing to the roughness of the surface of the aggregate particles.
2. Crushing strength of aggregate. The compressive strength of concrete cannot exceed that of the aggregate used. There in usually aggregate is considered ten times stronger than the crushing strength of concrete but some particles break also and influence its strength.

Physical properties of fine aggregate

1. Specific gravity. Specific gravity is defined as the ratio of mass (or weight in air) of a unit volume of materials to the mass of some volume of water at the stated temperatures in producing concrete aggregate. Generally, contains pores both permeable and impermeable. The specific gravity of most aggregate varies between 2.6 and 2.8
2. Bulk density. The weight of aggregate that would fill a container of a unit volume is known as bulk density of aggregate. Bulk density depends on how densely the aggregate is packed and consequently on the size distribution of the particles

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3. Porosity and absorption of water by aggregate. The porosity, permeability and absorption of aggregate influence the resistance of concrete to freezing and thawing, bond strength between aggregate and cement paste, resistance to abrasion of concrete.

Coarse Aggregate

Coarse aggregate is used for making concrete. They may be in the form of irregular broken stone or naturally occurring rounded gravel. Materials which are largely retained on 4.75mm sieve size (say 5mm for convenience) are called coarse aggregates. Its maximum size can be up to 63mm (Omopariola, 2020).The maximum size of course aggregate used in a concrete mix influences the quantity of sand, cement and water and thus cost of mix that must be used to have a workable mix (Bajpai, 2020). The bigger the maximum size of aggregate in a mix, the lesser the quantity of sand and water and thus the cheaper, because the less water requirement, the less the cement requirement required to achieved workability.

Properties of Coarse Aggregate

Aggregate is one of the principles of concrete mix design is to use as much aggregate as possible (up to 75% or more). Aggregate is much cheaper than cement and is more satisfactory structural material than cement paste, (Robalo, 2021). To assess the quality of an aggregate, its properties must be determined as described in the relevant standard e.g. the BS 882: (Jaskulski, 2019). Apart from the amount of aggregate in concrete, another very important factor to be considered is that the aggregate must be of good quality, (Nwakaire, 2020).

Materials

1 **Waste Nylon:** The waste Nylon materials were sourced and used. Other materials used are hand gloves, nose masks, safety boots, melting container, metal shaft for staring of hot mix, engine oil for lubrication, metal table for mold placement, and hand trowel

2 **Fine Aggregates (sand)**: Clean and dried Natural River sand was collected and used

II. METHODOLOGY

Manufacturing

In this research, the component manufactured was made from the waste Nylon and sand. Following are the steps involved in its manufacturing:

Melting

Light a fire under the metal container and gently heat it. Add the waste Nylon. As it warms up it will reduce in size. Waste Nylons are heated in a metal container at a temp of above 150˚. As a result of heating the waste Nylon melt. Keep adding waste Nylon gently until it melts down to a black liquid.

Mix

Mixing thoroughly until all the waste Nylon has melted. Stirring and heating must continue until it melts down to a black liquid. This can take up to 20 minutes. Do not let the liquid get so hot that it burns strongly. Add sand until you have the required mixture and keep mixing so that the waste Nylon, which acts as a binder, is very well mixed in and looks like grey cement

Mould

To give the molten waste Nylon their final shape of the interlock, a metal mold was made. Prepare the mould by making sure it is very clean, with no pieces of waste Nylon on it from previous moldings, and well oiled. And now this mixture is transferred to the mould. It will be in hot Condition and compress the molten Nylon and Sand to make it compact well to reduce internal pores present in it. Then the interlocks are allowed so that they harden. After drying the interlock is removed from the moulds and ready for the use

Waste Nylon Melt and Sand Mix Ratio

Production of interlocks by mixing waste Nylon melt and sand in a proportion by volume in ratio of 70:30. (3:7) 70% waste Nylon and 30% sand

Compressive Strength Test

The Universal Testing Machine was used to measure the load that crushes each sample. The compressive strength was calculated using the following formula:

Compressive strength=Load/Area.

Abrasion Resistance

The abrasion resistance will be obtained using the formula in equation below.

$$\text{Abrasion resistance} = \frac{W_1 - W_2}{W_2} \times 100$$

Where, W_1 is initial weight of a concrete specimen and W_2 is final weight of a specimen.

III. RESULT AND DISCUSSION

Table 1
Compression test result of Compression Strength of Waste Nylon and sand Interlock and Concrete Interlock

S/N	TYPES OF INTERLOCK	COMPRESSIVE STRENGHT (Nmm^2)
1	Waste Nylon and sand interlock	8.9
2	Concrete interlock	7.14

Source: Research work (2021)

From the above table it can be observe that interlock produced with waste Nylon and sand achieved the compressive strength of ($8.9N/mm^2$) While concrete interlock achieve the compressive strength of $7.14N/mm^2$. Samples indicate Concrete interlocks have low compressive strength of $7.14N/mm^2$. While interlock produced with waste Nylon and sand is having highest compressive strength of ($8.9N/mm^2$).

Table 2 Abrasion test Result

S/N	Types of interlock	Weight loss (gm)	Thickness loss (mm)	Abrasion Resistance
1	Concrete interlock	17	1.68	1.52
2	Waste Nylon and sand interlock	15	1.37	1.67

Source: Research work (2021)

The above results indicated that concrete interlock is having loss of weight of 17gm, Thickness loss of 1.68 mm and Abrasion resistance of 1.52 while the waste Nylon and sand interlock is having loss of weight of 15 gm, Thickness loss of 1.37 mm and Abrasion resistance of 1.67. The perfection was due to good adhesion between waste Nylon and sand.

Table 3 Comparison of waste Nylon and sand interlock and concrete interlock

S/N	Property	Concrete interlock	Waste Nylon and sand interlock
1	Appearance	Good	Better
2	Initial Cost	High	Low
3	Visual Abrasion Resistance	More	Less
4	Strength of floor tile	Less	High

Source: Research work (2021)

IV. CONCLUSION

The study has capably and successfully establishes the application of waste Nylon into useful constructional material as well as reducing its threat in our surrounding. The waste Nylon under attack all over the environment can be converted to useful constructional materials more inexpensive than cement. Base on the outcome of the results of the tests carried out, the study has clearly established that the waste Nylon resulting interlocks are stronger, a very cheap price, durable, and Abrasion resistant compared to the interlocks produced from conventional material (cement).

V. RECOMENDATIONS

- The exploitation of waste Nylon in production of Interlocks has creative way of disposal of waste Nylon. The Government should invest in using waste nylon to produce interlocks and create more awareness of this innovation to the community; this could serve as waste decrease and employment chances.
- Recycling of waste Nylon must be employed at all stages so as to prevent indiscriminately dumped in drainages, gutters, and the streets which end up blocking flow of water in drainages thereby causing flooding

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Plate 1 Heating waste Nylon and Adding sand

Plate 2 Casting and Drying of waste nylon interlock