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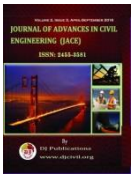

RESEARCH ARTICLE

Installation of Durable Runway using Firm Concrete Composite

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ABSTRACT

The main intention of this paper is to build up a low volume and long lifetime runway by employing a composite, made up of glass aggregate, polymerized asphalt and epoxy adhesive. The foamed aggregate is manufactured from unwanted glass materials. The asphalt obtained from the distillation of petroleum is blended with polymer waste to improve its properties and to manage the wastes. Finally the adhesive is used to bind all the materials that are used to lay the runways. The laid runway, thus has a better mechanical strength and can withstand large braking force.

Keywords: Runway, Asphalt, Glass aggregate, Epoxy adhesive, Polymer waste.

1. INTRODUCTION

Runways are the most important part of the airport since they have been used for landing and take-off purposes. Generally runways are more vulnerable to cracks because of the landing and braking of heavy aircrafts. Because of such effects, the life time of the runways get decreased.

[1] revealed the usage of spumed bitumen in side walk of airport, thus making the sidewalks more stronger. The paper has also suggested the advantages of bitumen in mixing with concrete for equalization and had highlighted its features. [2] highlighted the detracting stress aspects of Steel Reinforced Concrete (SFRC) in opposition to concrete. Numerous advantages of SFRC have been mentioned in this paper; on the contrary the stress bearing ability of SFRC cannot be determined in several situation. [3] evaluated the available latest technologies and raw materials for the construction of aero dram and its maintenance. From the study it has been concluded that constructural concrete is firm but still the resistivity of the material has to be increased. [4] proposed a new experimental degradation representation based on the slanting inconsistency of the exterior properties of the runway. Even though this method is efficient, the progression of this method consumes more time.

[5] investigated response of the sectional replacement of rough and fine crushed stones by steel debris on numerous properties like strength, persistence, etc. The flexible and twisting ability of the concrete increase; yet the condensation strength of the concrete get reduced. [6] illustrated the shear force of the asphalt structures due to the constraint forces of the aviation. Though satisfactory results were obtained for certain limited areas, further research work has to be done in order to figure out the traits that lead to shearing stress. [7] discussed the enhancement in the behaviour of soft soil by the addition of fly ash with a view of using material for construction purposes. Some characteristics of the soft soil remains unchanged but the moisture content and arid density gets shrinked due to the addition of fly ash.

[8, 9] analysed the characteristic features of High Performance Fibre Reinforced Concrete (HPFRC) obtained from the fibres of blazing basalt rocks. Still, eventhough HPFRC is very efficient, the cost of manufacturing is too high and it is not economical. [10] suggested an approach to improve the life span of pavements by infusing morsel rubber into cement concrete as an alternative to sand. The resultant material has been found to be good for roadway construction, yet the compression strength of the cement gets reduced by the addition of rubber. [11] elucidated the benefits of concrete framework built using least carbon utilities to increase the life span of concrete constructions. The suggested method has a

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little shedding of carbon dioxide despite the fact that it has a lower life span when compared to regular cement.

[12] examined the chance of adopting the furfural based adhesives to enhance the properties of concrete. Even though the proposed binder has lot of adorable qualities, lot of research work is needed to implement it practically. [13] interpreted a new approach to increase the life span of the cement concrete for construction purposes by the usage of regional industrial and agricultural wastes. Although this method consumes low energy, the properties of regular cement concrete gets altered due to the addition of regional raw materials. [14, 15] spelled out the response of combining regular cement and carbonyl added styrene butadiene to develop the sturdiness of the road over time. Only for a certain percentage of cement and styrene butadiene the strength of the road gets increased and further if the percentage is increased or decreased the properties of emulsion gets altered thereby decreasing its strength.

[16] constructed a different approach for the construction of roads using blazing asphalt and polymer wastes to improve the performance. The examinations has been conducted only on the waste obtained from the petroleum industries and so research work need to be done from the polymer wastes obtained from other industries also. [17] conducted experiments to determine the effect of quality of substances used in the construction of roads. From the research it has been concluded that safety of the roads depend upon the good quality of materials and its outlook.

This paper suggests an approach to improve the durability of the airport runways through the construction of strong composites. The manufactured composite is very firm, sound and reliable and have a longer life span.

2. METHODOLOGY

2.1. Runways

Runways are artificial surfaces that are intended to land and take-off aircrafts. Depending upon the available surface, the dimensions of the runways vary from 500 m-4200 m with a breadth of 25 m-60 m. Mostly runways are layered using grass, gravel, asphalt, bituminous, composite, concrete, etc. which is highlighted in figure 1. Runways usually have threshold markings that denote the start and end for landing the aircrafts.

Figure 1.Various runway surfaces

2.1.1. Types of runways

- Visual Runways

Visual runways are generally used in small airports which are fabricated using concrete, crushed stones, grass, etc. In visual runway systems, there will be no communicating devices and markings. Only through the perception of pilots, landing of aircrafts takes place.

- Inaccuracy Instrument Runways

In this runway system, the pilot will be able to communicate to the station to land the aircrafts parallel to the surface through some equipment.

- Accurate Instrument Runways

In this system, instructions will be given to the pilots to land aircrafts in both parallel and perpendicular planes through accurate equipment.

2.1.2. Problems in construction of runways

- Larger surface area is necessary for constructing runways.
- The runways could be laid only in the levelled surfaces.
- Availability of raw materials.
- Transportation of raw materials to the desired area.
- Initial and labour cost is very high.
- Runways are more prone to cracks due to the landing of heavy aircrafts.

2.2. Construction of runway surface

The strong surface of runway is built using a new sustainable material. The surface consists of three layers namely a low density aggregate, polymer cement and an adhesive. The runway thus constructed will have a longer life span and better strength properties.

2.2.1. Fabrication of aggregates using recycled glass

Aggregate is a substance composed of loosely bounded material. This is the major material in any type of construction. In this paper, aggregates are fabricated from waste or unwanted glass materials. Unwanted glass bottles along with a little amount of pure glass materials were used for fabrication purposes. First all the raw materials are cleaned to remove the unwanted impurities. Generally purification of glass materials takes place with the help of heating and separation. Once heating is performed, the raw materials are crushed mechanically to convert it into powdered form. The powdered glass is then assorted with calcium sulphate to facilitate the production of bubbles and then required amount of water is added to it. The mixture is then subjected to heating in the temperature range of 700°C to 900°C.

The mixture thus obtained is passed through a conveyor belt in which heating is performed again to maintain the temperature. Subsequently, cooling is done in order to condense the by-product. Later the condensed product is fractured to form the aggregate. The aggregate thus obtained is a low density material which is displayed in figure 2.

Figure 2.Manufactured aggregate

2.2.1.1. Properties of aggregate

- Aggregates manufactured from recycled glass are ecologically safe.
- They are sound and safe.
- These aggregates have a longer life span.
- They are mechanically very strong and easy to handle.
- They have very high load bearing capacity.
- They are very much resistive to humidity, moisture and frost.
- They are very light in nature.
- They are fire defiant.
- They are capable of withstanding very high temperature and have high melting point.

2.2.1.2. Applications of aggregate

Aggregates are used widely in the construction

- As a stuffing material.
- As a support for rigid structures.
- As a material to withstand weight.
- As an impregnate substance.

2.2.2. Manufacturing of Asphalt-Polymer cement

Asphalt is an inorganic substance that is firm, flexible and binds materials. Generally asphalt is obtained as a residue from the distillation of petroleum. In the distillation process, crude petroleum is first heated in the distillation column and then inorganic alkalis are removed. Subsequently the crude petroleum is further heated and allowed to cool in the distillation tower. Different useful materials such as LPG, kerosene, gas oil, naphtha will be collected from the distillation tower at different points. The slit obtained from the refining process is known as asphalt.

The asphalt thus obtained is then mixed with polymer wastes such as polypropylene and poly. First plastic bags and bottles were collected in large amounts by identifying the recycling codes. All the plastic wastes are cleaned and subjected to sink-float separation where polypropylene is separated. The separated polypropylene is added with the asphalt to improve the performance. The mixture is heated at high temperature to reduce its viscosity thus forming asphalt cement as in figure 3.

Figure 3.Produced asphalt-polymer cement

2.2.2.1. Properties

- Asphalt-polymer has a longer life span than regular asphalt cement.

- Asphalt-polymer cement is more stable.
- Asphalt-polymer cement has high resistance to the passage of air.
- Asphalt-polymer has high opposition to cracks formed due to heat.
- Asphalt-polymer have high resistance to humidity.
- Asphalt-polymer can be melted easily.
- Asphalt-polymer has good drainage properties.
- Asphalt-polymer is mechanically very strong.

2.2.3. Preparation of epoxy clingy

Epoxy is generally used as an adhesive for concrete because of its outstanding properties. Epoxy is formed by the chemical reaction of EpiChloroHydrin (ECH) with anyone of the materials like BisPhenol-A (BPA), phenol, cresol novolacs, glycols etc. Here ECH is first combined with BPA in a reactor vessel and then sodium hydroxide is added to the solution and blistered. Later onwards in the evaporation process, methyl isobutyl ketone is added to the boiled solution to separate the liquid and solid states. The resultant product is then washed with water and suitable additives are added to it to enhance its properties. If solid state epoxy is needed, the aqueous solution is removed through vacuum distillation. Further heating is done at higher temperature to obtain hard epoxy.

2.2.3.1. Properties

- Epoxy sealers are more firm than acrylic sealers.
- They have an immense adhesion level.
- Epoxy sealers are more rigid and reliable.
- They have a longer life time.
- They have more flexibility to adapt to concrete.

2.2.3.2. Applications

Epoxy finds applications in various fields such as

- As a sticky agent in construction fields.
- As a filler in the manufacturing of electrical equipment.
- In industries to manufacture laminations, casts, linings, molds etc.
- To stop certain layers in petrochemical industries.
- As a sealer in concrete structures, ships, aircrafts, etc.

3. RESULTS & DISCUSSIONS

Crude petroleum is subjected to fractional distillation where asphalt is obtained as a residue. Some amount of the residue is taken and kept aside for levelling purpose. Plastic waste are collected from which polypropylene is separated from the materials through sink-float mechanism. This poly propylene is added to the slit and then heated to obtain the asphalt-polymer concrete.

Similarly foamed aggregates are manufactured from unwanted and broken glass materials. The raw materials is first heated, crushed, condensed and fractured to get the desired aggregate.

ECH and BPA are mixed in the reactor vessel with the addition of sodium hydroxide solution and then boiled. By adding methyl isobutyl ketone liquid phase is separated and suitable additives are added. The produced aggregate, asphalt-polymer cement and epoxy sealer are mixed in 3:5:2 ratios to obtain the composite. The entire manufacturing of the composite is given in figure 4.

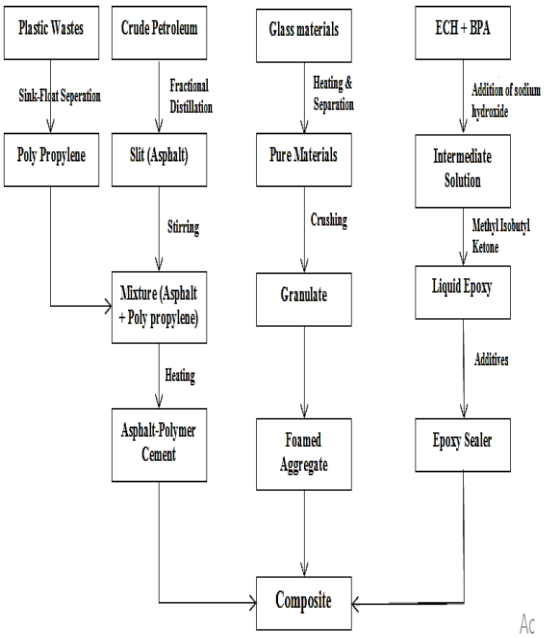

Figure 4.Entire process of composite formation.

The properties of the proposed concrete containing sand, glass aggregate, asphalt-polymer cement, epoxy sealer and water is compared with regular concrete containing gravel, sand, Portland cement, asphalt and water as in figure 5.

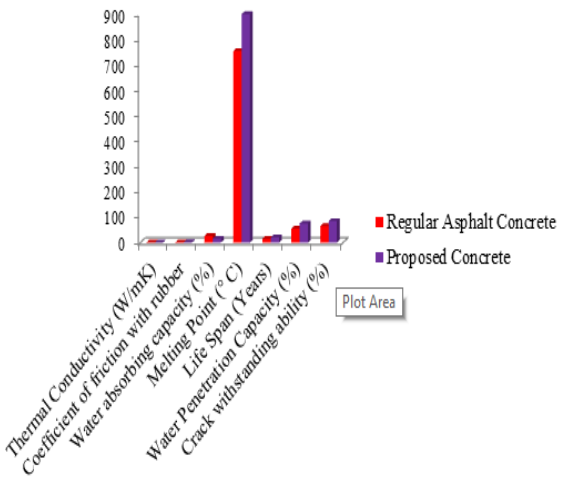

Figure 5.Comparison of proposed concrete with regular concrete

The above figure shows that the proposed composite has better performance and properties than normal concrete. Moreover the life time of the proposed composite is nearly 20 years and it requires almost no maintenance during its life span.

Appropriate surface for laying runway is chosen for a length of 1500 m and 55m width. Initially ground surface is first surveyed and then levelled using vehicles. Asphalt in liquid state obtained from the distillation is mixed with sand and this mixture is applied over the levelled surface and left to dry completely for a period of one week.

After one week, again a layer of asphalt-polymer in liquid state is applied over the surface for a thickness of 7 kg. The asphalt-polymer cement, heated asphalt residue, glass aggregate, water, epoxy sealer and sand are mixed to form a strong concrete. The concrete is spread over the surface and a roller is made to roll over the surface in a speed of 4 km per hour.

After allowing the composite to settle for few hours, a coating of epoxy sealer is applied over the surface to enhance the strength. The laid runway is allowed to dry under the sun for about 28 days which is exposed in figure 6.

Subsequently, in the runway, markings have been done. The threshold markings were made for a length of 200 m and width of 50 m as in figure 7.

Appropriate lightings were made by harvesting the solar energy. A small aircraft was made to land on the constructed runway to determine the ability of the runway. The volume of this runway is found to be 0.5 times smaller than the ordinary runway.

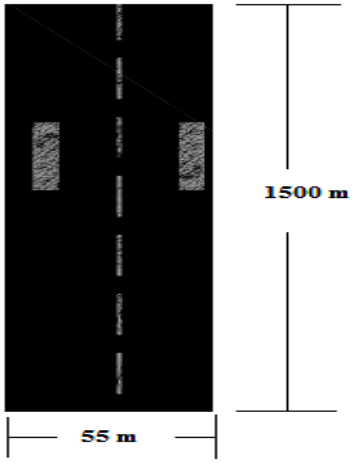

Figure 6.Constructed runway

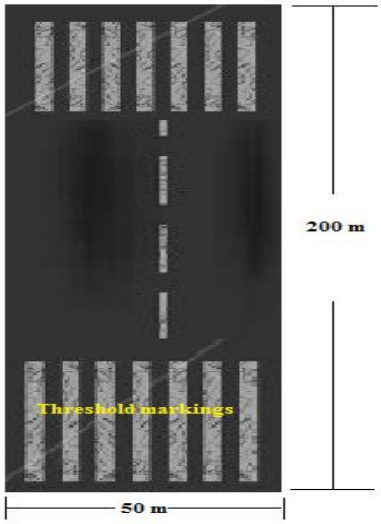

Figure 7.Threshold markings

4. CONCLUSION

Thus a firm and sound runway has been constructed that could withstand large braking force of the aircrafts besides having long durability. The proposed concrete could be used for laying highway roads also.

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