UCT JOURNAL OF RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY 2018(02)

Available online at http://journals.researchub.org

Evaluation of Forta fibers performance in hot asphalt mixture against concrete cover

Sajjad Kafashzadeh[1*], Asadolah Jalal Zadeh[2] and Mohammad Fadavi[3]

[1]*Professor of Civil Engineering, Islamic Azad University, Birjand Branch, Iran*
[2]*Bachelor of civil engineering‹islamic azad university‹zahdan branch*
[3]*Master of civil engineering‹road and transportation‹payame noor university international center of asaluyeh*

ARTICLE INFO

Article history:
Received 16 Oct. 2017
Accepted 20 Jan. 2018
Published 24 Feb. 2018

Keywords:
Forta fibers,
Fatigue cracks,
Asphalt mixture,
Asphalt polymeric,
Glass Fiber Ashpalt

ABSTRACT

Today, the use of concrete fiber coatings is a common method worldwide due to the high speed implementation and thickness reduction of the reconstruction of concrete and asphaltic roads. These construction projects include concrete pavements including road surfaces, bridge decks, runways, parking lots and industrial floors. Fibers in concrete pavements, in addition to reducing the slab thickness and economical efficiency by controlling the shrinkage cracks and reducing the number of transverse joints, reduces the penetration of water into the pavement and leads to a reduction in maintenance costs. The important factors influencing this are the appearance of the shape and the geometry of the fibers, which is an important factor in the mechanical control of the fiber in concrete. This paper intends to evaluate the flexural strength and cracking strength of concrete made with different types and forms of polymeric fibers Specific Concrete (produced internally by the Sirjan Foundation of Knowledge) considering the applicability of concrete concretes in concrete applications. The analysis of the results obtained from the experiments show that the use of fibers increases the flexural strength and cracking resistance and the shape of fibers can improve these properties. One of The main breakdowns occurs in flexible pavements are the melting of asphalt layers, the most important of which are fatigue, which is caused by traffic and caused by the effects of successive temperature changes. Improving the flexural strength and increasing the strength of the asphaltic layers against fatigue from various methods including The use of various additives such as fillers, fibers and materials, nano-polymers in asphalt mixtures is possible. The results of the experiments showed that the fatigue behavior and performance of the armed mixture with the Forta fibers were significantly improved compared to mixture. Today, the use of polymer modifiers, fibers and nano-materials to improve the properties of bitumen and improve the performance of asphalt mixtures can be very effective, but relatively expensive due to the cost of implementing relatively rarely, the recycling of materials and their use as secondary materials in asphalt mixtures In addition to helping reduce costs, it can have beneficial effects on the environment. Laboratory research suggests that Forta fibers play a significant role in arsenal mixtures. Also, the mixture has the highest amount of additive with the best fatigue behavior The most important positive effect of adding fibers to concrete is the increased flexibility of the concrete and increased absorption capacity of the concrete. In general, arming of asphalt mixtures with a minimum amount of 1.5 kg of fiber per ton of asphalt increases elastic behavior, which increases the fatigue life of the asphaltic mixture.

Introduction

One of the types of modern concrete is fiber concrete. Fiber concrete is, in fact, a composite composed of stranded and separated filaments that play an arming role in the concrete matrix. This composition is well-integrated and consistent and allows the use of concrete as a formable material. Today, industrial floors and pavements are considered as the main uses of concrete-containing fibers. Other important applications of concrete-containing fibers are external refinishing, Shotcrete, composite slabs on steel decks and pre-made elements. Researchers have shown that a variety of fibers can increase the abrasion resistance and tensile strength of concrete. The fibers can also be used to prevent plastic cracks, control crack widths, increase wear and tear, and increase the load bearing capacity of the slab. In ultra thin fiber concrete processes, bending durability, crack width control and increased bending load of concrete pavement are key parameters in the design and selection of fiber consumption. As fibers in the concrete body are dispersed in all directions, if a crack forms, the fibers in different directions create connections and prevent further expansion. Fiber fibers are therefore actively involved in limiting the width of the crack and increasing the ability to use concrete. Two important issues regarding the use of reinforcing fibers in concrete pavements are raised. One is the type of fiber used and the other is the amount used to add to the ordinary concrete. A study of propylene fibers with different volumetric percentages was investigated on the flexural strength of concrete. For this purpose, 10x10x50 cm beams were used to test bending durability. Test variables consisted of four percent volumetric fibers (0, 0.5, 1 and 1.5%) as well as two field strengths with a water / cement ratio of 0.4 and 0.5. The results of the experiments showed that increasing the amount of polypropylene fiber to concrete increases the energy absorption and especially the tensile strength of the tone. In another study, the effect of

**Corresponding author:* sajjadkaffashzadeh@yahoo.com
DOI: https://doi.org/10.24200/jrset.vol6iss02pp13-21

increasing the percentage of polypropylene fibers in hybrid fiber concrete has been investigated. Three percent polypropylene fibers have been replaced in 1% of steel fibers. Finally, the mechanical properties of the hybrid polypropylene fiber reinforced concrete specimens have been compared, including strength and flexural strength and impact strength with each other and the control concrete. The results of the experiments indicate that the polypropylene fibers have the potential of bridging on the fine cracks and have little effect on improving the behavior of the concrete after the first cracking. The more steel fibers replaced with polypropylene fibers, the less flexural strength and energy absorption and impact resistance. In a study that tested forta fibers in concrete, they found that with increasing the amount of forta fibers in concrete, the flexural strength of the samples increased to 4%. In the research that the Forta fiber manufacturer produced, the following results were achieved: adding 1.5 kg of Forta fiber 1 tone

2 - Formation material containing Forta

2.1 Specifications of Forta Fibers:

The HMA type fibers are designed to operate at temperatures between 120 ° C and 190 ° C.

• Available in both Batch Mixer and Drum Mixer.

• Capable of mixing and spreading in all asphalt tiles.

Aramid	Polyolefin	material	row
single-stranded	Stranded and single-stranded strings	shape	1
1.44	0.91	Special Weight	2
400000	70000	Tensile strength	3
19	19	Length(mm)	4
yellow	Black	color	5
Ineffective	Ineffective	Acid / Alkali resistance	6
427	100	melting point	7

Table 1: Physical Characteristics of Forta Fibers

Forta fibers is used at 0.5 kg in the laboratory and 1.5 kg in the factory.

3. Research history

Nowadays, experts are looking for a new technique for building road pavement that is environmentally friendly. The cracks in the pavement cause more problems than other types of structures, as there will be plenty of problems in addition to machining problems at the service level. Among the important failures in pavement, fatigue cracks occur at medium to low temperatures.

Reports indicate that asphalt pavements of varying degrees of hardness, thickness, percentage of free space and different percentages of bitumen can behave differently from fatigue.

In recent decades, a wide range of additive modifying agents has been investigated to improve the properties and behavior of bitumen and asphalt mixtures. Examples of these additives are polymers that have the greatest potential for use in flexible pavement design. In a study that evaluated the fatigue properties of modified asphalt mixtures with three types of cellulosic, polyester, and inorganic fibers, it was concluded that mixing with polyester fibers had a better effect on fatigue properties than two other types.

In another study, it was concluded that the durability of flexural and tensile mixes of asphalt can be improved by adding fibers and this effect is influenced by the type, amount and diameter of the fibers. According to the experiments performed on concrete on the fiber and the effect of polypropylene fibers on the behavior of concrete traverses, it was found that the optimum polypropylene fiber has been selected and the flexural strengths increased by 33 and 11 percent, respectively.

In a study that tested forta fibers in concrete, they found that with increasing the amount of forta fibers in concrete, the bending strength of the samples increased by 4%.

In a study by the Forta fibers manufacturer, the following results were obtained: 1 forta fibers in 5.1kg; asphalt mix: increased the asphalt modulus by 9.1 to 3.1 times, resulting in a decrease in the thickness of the asphalt layer and substrate layers.

4. Resistance to thermal cracking is equalized.

Resistance to crack expansion and reflection is 41 times higher.

Fiber asphalt

Fiber asphalt is a mixture of ordinary asphalt and artificial fibers consisting of aramid and olefin fibers and other poly-materials, which are durable and highly resistant to adhesive properties. Reducing and delaying cracking, thermal cracking, fatigue and reflexive asphalt leads to a cost-effective economic advantage by reducing the thickness of the asphalt layer and increasing its life span.

5. Fibers performance in asphalt:

The performance of the fibers in the asphalt is such that, when passing heavy vehicles or in high traffic loads, fiber strands in the asphalt by distributing and dividing the wheel pressure in all directions and layers prevent the damage of the main part of the asphalt pavement.

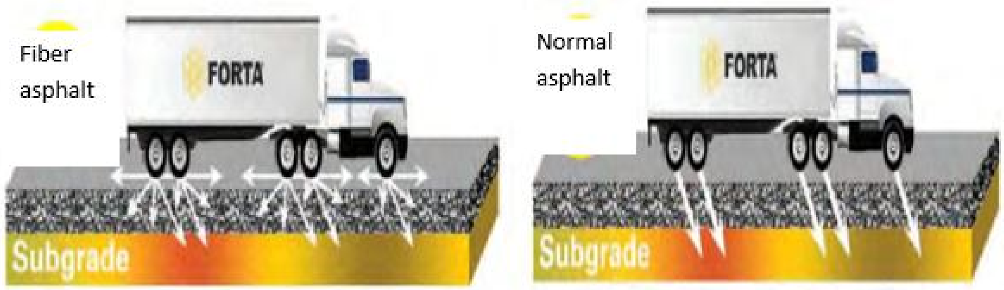

Figure1: Fiber function in asphalt

6. Forta Format:
HMA-type fibers are designed to operate at temperatures from 121 to 181 degrees Celsius.
Capable of using both Batch and Drum mixers.
The ability to mix and spread in all asphalt tissues

Aramid	Polyolefin	material	row
single-stranded	Stranded and single-stranded strings	shape	1
1.44	0.91	Special Weight	2
400000	70000	Tensile strength	3
19	19	Length(mm)	4
yellow	Black	color	5
Ineffective	Ineffective	Acid / Alkali resistance	6
427	100	melting point	7

Table 2: Physical Characteristics of Forta Fibers

Fortador fibers of the laboratory in kilograms and 5.1 in the factory are used in quantities of 5.1 and 1 kg per ton of asphalt.

7- Introduction of materials:
The properties of consumable materials in the research are presented below. Mineral stone materials in western Tehran have been prepared. Sand grains of pewter grains with a density and water absorption of 2.5 kg / m3, 2.5%, and of hydroponic type with a density and water absorption of 2.6 kg / m 2 and 0.2% respectively have been. The modulus of softness, density and water absorption of sand is 3.5, 2.6 kg / m3 and 2.9%, respectively. The gravel and sand gravel is shown in Figures 2 and 3, respectively. The two gravel ratios (80% almond and 20% chickpea) were selected so that the grain size of these two types of sand would be within the national standard 4977. As shown in Figure 2, the sand gravel composition is within the standard range.

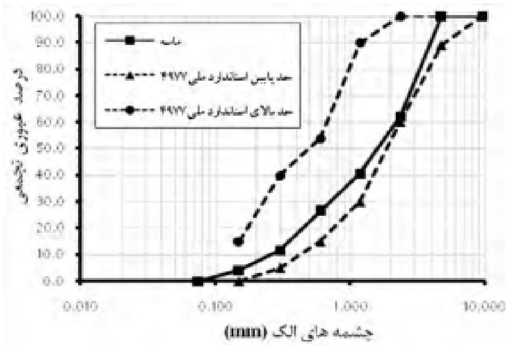

Figure 2: Sand gravel curve used

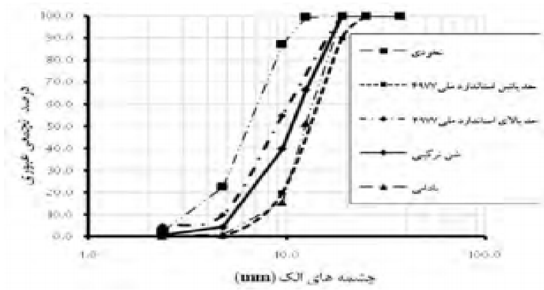

Figure 3: The sand graining curve used

The cement used in the manufacture of all samples is Tehran Type 2 cement. The X-ray Fluorescence Test (XRF) has been carried out to determine the chemical properties of cement at the site of the chemical analysis laboratory of the Geological Survey and Mineral Exploration Organization of the country. The chemical properties of these materials are given in Table 3. The water used in the manufacture of samples is urban drinking water.

Type of chemical composition	SiO2	CaO	Al2O3	Fe2O3	MgO	SO3	K2O	Na2O
Percent	17.7	64.2	3.5	4.1	2.7	3.7	0.9	0.2

Table 3: Chemical composition of cement materials used

In order to investigate and compare the effects of using specific types and geometry of concrete polymeric fibers and domestic production, four samples of different types of polymeric fibers manufactured inside the country (Knowledge-based Complex of Nanotail and Granular of Sirjan) with the names of Curta Twist Fiber, Curta Embas Fiber, Fiber Curta corrugated and curtatwist fiber of 1kg / m3 were used in concrete. The specifications and characteristics of these fibers are given in Table 4.

Density	Length	Shape	Fiber Type	Fiber Code	row
۰/۹۱	۵۴		**Curtatwist** Several macro and micro twisted filaments with high modulus and high resistivity of modified polyolefin	۱۰۴	۱
۰/۹۱	۵۴		**Curta Embas** Composite thick fibers with high strength and modulus of modified polyolefin materials	۲۰۲	۲
۰/۹۱	۵۴		**Curta corrugated** Micro-coarse and micro-coiled multi-component filaments of modified polyolefin materials with high strength and modulus	۳۰۳	۳
۰/۹۱	۵۴		**Needle Curta** Needle-shaped filament fibers with high modulus resistance and modified polyolefin	۴۰۴	۴

Table 4: Specifications of the fiber used

8. Mixing and manufacturing samples:

Experimental blends of fibers with 1 kg of fiber per m 3 are made. The concrete mix design for the control and fibers for the ratio of water to cement is 0.5 and the specific gravity of 2315 kg / m3 and according to ACI211 in Table 3. There is also an illustration of the steps involved in the construction and maintenance of a number of primer samples made in Figure 3.

Quantity(kg per m^3)	Materials	Row
880	Gravel	1
835	Sand	2
400	Cement	3
200	Water	4
1	Fibers	5

Table 5: Specification of the mixing plan

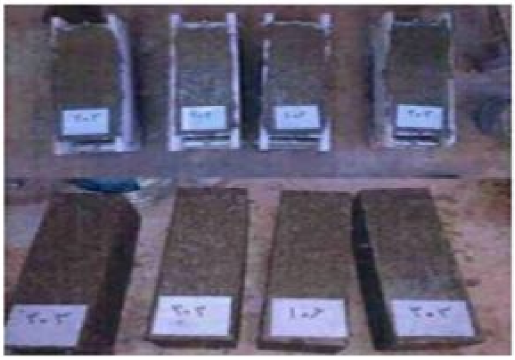

Figure 4: Image of a number of prism examples

9. Flexural Strength:

One of the important properties of fiber concrete is the ability to transfer stress in a cracked section, which is generally known as flexural strength. The bending durability is obtained from the calculation of the surface below the load displacement graph. In this study, according to the 12-C1609M / ASTMC1609 standard, the flexural strength of four-point fibrous concrete with a mixing plan according to Table 5, and using the calculation of the displacement load curve in the middle of the crater, the bending strength values and also with the help of the standard C1018 ASTM at the age of 28 days.

Figure 5: An image of one of the patented test specimens

10. Resistance after Mutation 1 (ARS):

The residual strength or crack resistance is said to be tolerated by the fibers after cracking and breaking in concrete, and the fibers prevent the complete breakdown of the concrete to the final breakage. In this study, the results of this test were calculated according to the equation 1 and according to the ASTM 1399 standard, the mean residual fiber resistance of the concrete.

ARS P P P P□ □ □ □ □((A B C D) / 4) K)1

Where we have:

K=L/bd2 , mm-2

Residual Average (MPa) (= ARS

The total load recorded in the specified displacement (Newton) = PD + PC + PB + PA

Span length (mm) (= L

Beam width (mm) (= b

Beam depth (mm) (= d

11. Results of the test of resistance and durability of bending:

The results of flexural strength tests and bending strengths are presented in Table 6. As shown in this table, the greatest amount of flexural strength is observed in the specimen containing corrugated fiber (code 303) and later in the sample (code 106). This can be because, due to the fact that these two types of fibers have a greater number of shifts (waves and bolts) along their length, these properties make it more adhesive and better engage the fibers with the mortar, as well as the results of the flexural strength of all the samples containing The fibers have a higher flexural strength than the non-fibrous specimen. Among the fiber-containing specimens, the highest bending strength is observed in the specimen containing corrugated fibers. Increased stiffness can prevent cracking, or at least increase its growth due to thermal and temperature changes. Delayed in addition, it can be resistant Increases the dynamic loading (caused by fatigue, impact, seismic events and explosions). The key to increasing the flexural strength of a concrete mixture arranged with mixed absorption fibers and reducing the width of the cracks, which can be very beneficial to improve the performance of concrete pavement While the use of fiber reinforced concrete in pavements has many advantages and can solve some problems with the use of reinforcement. These include the provision of fittings, the reduction of transportation problems, the health and safety problems, and the removal of problems related to the absence of proper fitting of reinforcement.

Bending strength Mpa	Maximum force Kn	Durability Jul	Fibers Code	Row
۴/۴۸۵	۱۴/۹۷	۶/۱۸	۱۰۶	۱
۴/۴۶۵	۱۴/۸۹	۶/۱	۲۰۴	۲
۴/۷۷	۱۵/۸۹	۶/۷	۳۰۳	۳
۴/۵۳	۱۵/۷۵	۶/۱۵	۴۰۳	۴
۴/۰۵	۱۴/۴۲	–	Cc1(شاهد)	۵

Table 6: Results of flexural durability and bending strength at 28 days

12. Residual Resistance Average:

The results of the residual average on the samples containing various fibers are shown in Table 7. Also, the graphs of the load-displacement curve of samples containing fibers after the melting are shown in Fig. 6. As can be seen from this table, the residual resistivity remains close together in the twist, embas and wavy samples, so that the highest cracking resistance in the specimen containing the corrugated fiber is observed. Also, the least resistance after mating was observed in the specimen containing needle fibers. After examining the broken surface of the samples, it was found that in samples containing needle fibers that have smooth and direct surfaces, the fibrousness of the mortar was less so that there was no good adhesion to the mortar, and sometimes the fibers were extracted from the mortar.

Residual Resistance Average MPa	Fibers Code	ردیف
۰/۶۷	۱۰۶	۱
۰/۷۳	۲۰۴	۲
۰/۷۷	۳۰۳	۳
۰/۱۳	۴۰۳	۴

Table 7: Results of the test Average residual resistance at the age of 28 days

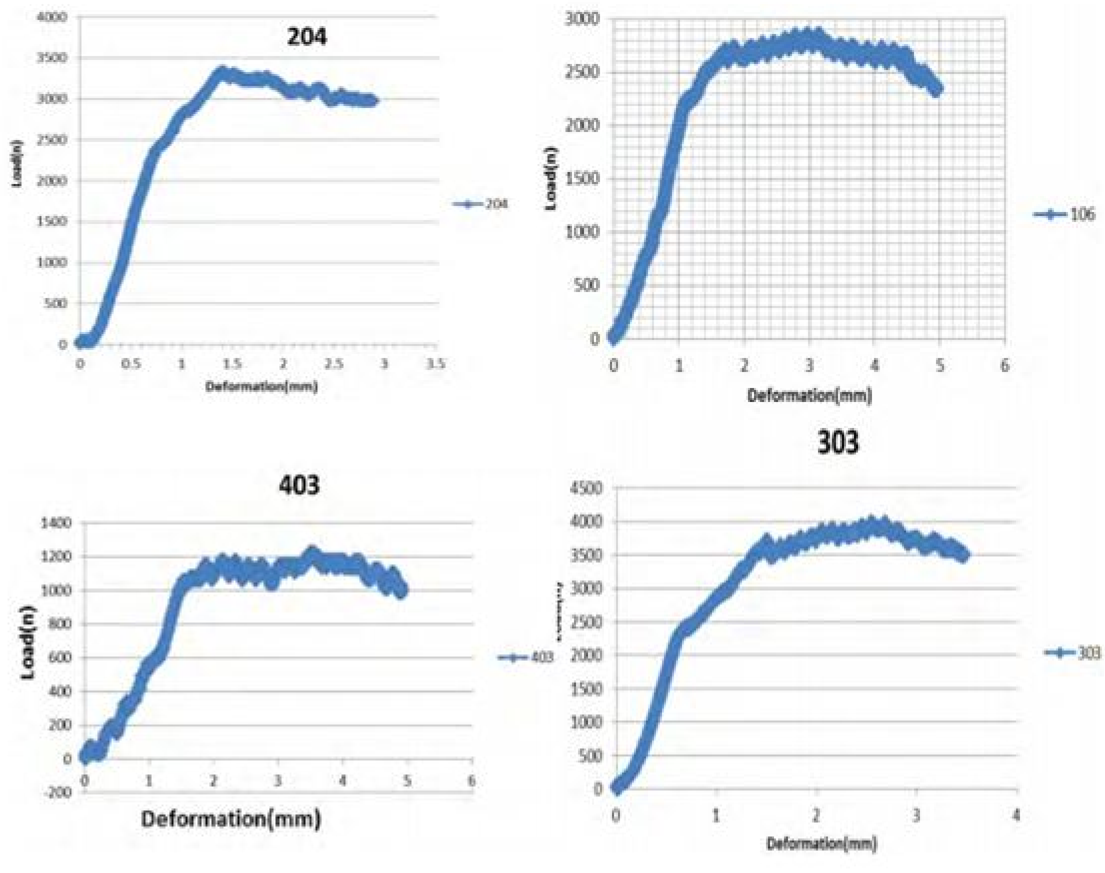

Figure 6: Load curves - Displacement of various samples after cracking

13. Experimentation with Forta Format:

13-1- Straight Trial Test:

A type of fatigue test is that the loading is repeatedly applied to a cylindrical specimen so that the load pressure of the cylindrical bundles is applied in parallel and vertically. This form of loading causes a uniform tensile stress in the sample that is perpendicular to the loading and during the cylindrical sample. Typically, the loading pulse in this experiment is semi-sinusoidal. The horizontal deformation of the sample is recorded as a function of the load cycle, and the sample equilibrium, which corresponds to the sample failure, is obtained.

It is determined that fatigue cracking is a type of pavement failure that generally occurs at mid-service temperatures, so a temperature of 21 degrees is recommended for testing.

Two controlled loading types can be applied in this test: controlled tension and controlled strain. In the first step, constant stress and sample strain increase with increasing number of load repetitions. In the controlled strain, the strain remains constant and the amount of stress decreases with increasing number of load repetitions.

13-2 Indirect Tensile Testing

A type of fatigue test that is loaded repeatedly onto a cylindrical sample so that the pressure load is applied to the cylindrical faces in parallel and vertical. This form of loading causes a uniform tensile stress in the sample that is perpendicular to the loading and during the cylindrical sample. Typically, the load pulse in this semi-change experiment is cynical. The horizontal shape of the sample is recorded as a function of the load cycle, and the fatigue life (Nf) (which corresponds to the failure of the sample) is determined. The fatigue cracking is a type of pavement failure. It is generally suggested that the temperature of the intermediate temperatures should be 21 ° C for testing.

Two controlled loading types can be applied in this test: controlled tension and controlled strain. In the first method, the stress is constant and the strain of the sample increases with increasing number of load repetitions. In the strain-controlled method, the strain remains constant and the amount of stress decreases with increasing number of load repetitions

14. Performance of Concrete Procedures:

One of the worries about the use of concrete pavement is the low slip resistance. Slip resistance refers to horizontal friction force, which prevents the wheel from moving when it is in direct transit. The lack of this friction causes an accident.

Concrete procedures today showcase the favorable benefits in pavement runways, loading and bus stations, increasing the contribution of the pavement, the use of these procedures is free of imperfections, such as: the direct effect of climate conditions on the mixing plan Primer and Concrete Performance Cracking Procedures, Slip Impact of Concrete Levels and Its Interaction with Car Tires.

The factors affecting the amount of shrinkage due to the drying of the concrete, the amount of concrete water, the concrete cross section, the environment of the concrete section, the amount of pressure and the type of cement, respectively, have the most effect on the amount of shrinkage due to drying and modify Concrete mix design can significantly reduce the amount of shrinkage due to drying.

Despite the advantages of using concrete procedures, the share of concrete in all of Iran's roads is about 4%. The use of concrete procedures in comparison with asphalt methods has a great effect on reducing fuel consumption, reducing greenhouse gas emissions and reducing financial costs, and these are the main steps in the sustainable development of any system, but the production of cement has a harmful effect It also has an environmental impact. The use of concrete coatings around the world is welcomed due to the small amount of environmental damage that can be eclipsed with flexible and low cost usage.

15. Using concrete procedures on most routes instead of bitumen:

According to the many years old concrete structures, it can be considered the most durable materials in construction. Concrete procedures are a good option for use on the tracks.

Using concrete procedures on most routes rather than bitumen can be considered as an ideal option according to expert experts and experts in this field. Concrete coatings can be said to be the most durable type of materials in most of the structures, which today use them to be cheap and almost durable materials such as bitumen.

16. Concrete coatings and their use in road construction:

Concrete coatings often use cement in their structure and composition as a hard and durable material that can be used in most roadways and interstellar urban roads. It is a prominent and important feature of concrete procedures dating back many years, which can be a solid reason for use in most construction and routes in the country. As time goes on and the rise of science and the discovery of practical and useful materials, including concrete procedures, they can be considered as a better substitute for asphalt road and road tracks rather than cheap materials such as bitumen.

17. Advantages of using concrete procedures instead of asphalt:

Concrete processes date back to the age of 80, whose history dates back to the ancient Roman times. This type of material due to the proper production and high cement production in the country can be considered as suitable for use on roads and free roads. However, due to the fact that cement production in the country does not undergo any recession, this item can be used for use From concrete on paths. The use of concrete coatings in today's world has become commonplace in most freely available ways in different countries. The durability and durability of concrete procedures are often much more than materials such as bitumen and asphalt.

18. Using Layer Basis:

In the past, concrete pavement was built directly on the bed. But with the increase in volume, traffic volume, and the occurrence of the Pumping phenomenon, the use of the basis of grains is quite common. When the pavement is affected by a large number of heavy loaded wheels and the base layer is adjacent to the surface of the groundwater, it is possible to wash the grain materials through water performance. The use of asphalt or cement base is considered as a common practice. Although the use of the base layer reduces the amount of critical stress in the concrete pavement, it can reduce the critical stress due to the fact that the strength of the concrete is much higher than the base layer's resistance, with a slight increase in the thickness of the concrete. Therefore, the use of the base layer is not economically feasible solely to reduce stress on the concrete layer.

19. Reasons to use the foundation:

19.1: Pumping Phenomenon Control

19-2: Control of frost

19-3: Improvement of drainage

19-4: Control of contraction and inflation

19-5: Ease and speed up construction operations

20. Type of concrete pavement:

20-1: JPCP seamless reinforced concrete pavement

20-2: Continuously armed reinforced concrete pavement CRCP

20-3: JRCP seamless reinforced concrete pavement
20-4: PCP pre-tiled concrete pavement

21. Advantage of Concrete Procedures Compared to Asphaltic:

Concrete procedures are preferred in areas with low bed resistance and heavy traffic over asphaltic pavement.
Concrete pavement maintenance costs are lower than that of asphalts.
The useful life of concrete is more than that of asphalt pavement (40 to 50 years, compared to 15 to 20 years).
Concrete reinforcement is preferable to asphaltic safety due to the increased visibility for users at night.
Concrete trowel thickness is lower than asphalt pavement. And as a result, in areas where the thickness limit exists, it is preferable to use materials as well.
Due to the savings in the use of aggregates in concrete, the destruction of natural resources and the environment is less.

22. Disadvantages of Concrete Treatments Compared to Asphalt Layers:

The cost of building concrete pavement is higher than that of asphalt pavement.
Performing repairs and repair operations in concrete pavement is more difficult.
The existence of expansion joints is one of the weaknesses in concrete procedures. Which contributes to the aggravation of deterioration and the destruction of concrete, in such a way that the maintenance and repair of the exhaust site in terms of concrete slurry is important.
Today, the Pomping phenomenon and the extinction of fine grains from the expansion joints in the absence of the use of drainage materials is considered as one of the weaknesses of concrete pavement.

23. Application of concrete procedures:

On roads in tropical areas with heavy traffic volumes, especially on steep slopes that are low in heavy vehicles.
At some parts of the road or runway route, the ground resistance is weak.
In the intersections and fields where the severe shear forces come from the brakes to pavement.
In areas where transportation costs and heavy goods costs are not economical.
At the beginning and end of the airport runways, the taxi faces and the operons use preference for concrete.

Conclusion

• The mixture has the highest fiber content, the best fatigue behavior, and tolerates the number of cycles to break through.
• Due to the poor performance of the mixing of Forta fibers in a mixture of asphaltic mixtures, the fatigue test was carried out at the factory.
• Fatigue behavior and fatigue behavior of mixed forks with Forta fibers improved significantly compared to control blend
• The fatigue life of a mixture of 1.5 and 1 kg of fiber per ton of asphalt is 2 and 34 times higher than that of the control mixture.
• Increasing the amount of fiber from 1.5 to 1 kg significantly improved fatigue life.
• In general, arming of asphalt mixtures with a minimum amount of 1.5 kg of fiber per ton of asphalt increases elastic behavior, which increases the fatigue life of the asphaltic mixture.
• Due to the poor performance of the mixing of Forta fibers in a mixture of asphaltic mixtures, the fatigue test was carried out at the factory.
• Fatigue behavior and fatigue behavior of mixed forks with Forta fibers were significantly improved compared to the control mixture.
• Accumulation of an array of mixtures of 1.5 and 1 kg of fiber per ton of asphalt is 2 and 34 times higher than that of the control mixture.
• Increasing the fiber amount by 1.5 to 1 kg improves the fatigue life. Generally, arming asphalt mixtures with a minimum fiber content of 1.5 kg per ton of asphalt increase elastic behavior, which increases the fatigue life of the asphalt mix.

Reference

[1] Mirzai, A. Nasrollahi m Investigating the properties of polyester reinforced asphalt pavements, 8th International Congress on Civil Engineering, Shiraz, 2009.
[2] Ismaili, M. Qahari, AS Experimental Investigation on the Effect of Polypropylene Fibers on the Traversing Concrete Behavior, Scientific and Research Journal of Civil Engineering. Modares, Tehran, 1381.
[3] Lotfi, AS. Ameri m Hesami, A. Laboratory review of the use of polypropylene fibers in mixtures of asphaltic. The first international conference on human, civil, architecture, urbanization, Tabriz, 1394.
[4] Ranjbar, M. Madandoost, m. Fadai, R The Effect of Forta Fibers on the Mechanical Properties of New Concrete, 6th Annual Iranian National Concrete Conference. Tehran, 1393
[5] Shekarchi, M. and Rahmani, (1393). "Practical Guide to Concrete Containing Steel Fibers", First Edition, Scientific and Publication.
[6] Takloo, Mohammad Reza and Reza Morshed, 2008, Effect of Polypropylene Fibers on Fiber Acid Absorption Energy, Fourth National Congress of Civil Engineering, Tehran, Tehran University.
[7] Rashiddadash, Pantea and Mansur Peidayesh, 2012, Investigation of Flexural Strength and Strength and Strength of Strength of Hybrid Fine Fiber Concrete of Polypropylene, 9th International Congress on Civil Engineering, Isfahan, Isfahan University of Technology.
[8]Cleven, M.A. Investigation of the Properties of Carbon Fiber Modified Asphalt Mixtures. Master. Thesis, Michigan Technological University, 0222.
[9]Aravind, K and Das, A. Dynamics of structures: Pavement design with central plant hot mix recycled asphalt mixes, Constr Build Mater, 0222.
[10]Moghadas Nejad, F. Aflaki, E and Mohammadi, M.A. Dynamics of structures: Fatigue behavior of SMA and HMA mixtures, Construction and Building Materials, 0212.
[11]NCHRP APPENDIX II-1, Calibration of fatigue cracking models for flexible pavements, 0222.
[12]Qunshan, Ye. Aksoy, A. Tayfur, S and Celik, F. Laboratory performance comparison of the elastomer-modified asphalt mixtures, Build Environ, 0222.

[13]Aravind, K. Shaopeng, Wi and Ning, Le. Dynamics of structures: Investigation of the dynamic andfatigue properties of fiber-modified asphalt mixtures, International Journal of Fatigue, 0222

[14]Ferrotti, G and Canestrari, F. Dynamics of structures: Experimental characterization of highperformance fiber-reinforced cold mix asphalt mixtures, Construction and Building Materials, 0212.

[15]Matthews JM, Monismith CL. The effect of aggregate gradation on the creep response of asphalt mixtures and pavement rutting estimates. ASTM STP 1992;1147

[16]Balghunaim F, Al-Dhubaib I, Khan S, Fatani M, Al-Abdulwahhab H, Babshait A.Pavement rutting in the Kingdom of Saudi Arabia: adiagnostic approach to the problem. In: Proceedings of 3rd IRF middle east regional meeting, vol. 6,Riyadh, Saudi Arabia, February; 1988. p. 210–32

[17]Abdulshafi A. Rutting-review of existing models and some application to Saudi Arabia. In: Proceedings of 3rd IRF middle east regional meeting, vol. 6, Riyadh,Saudi Arabia; February 1988. p. 244–56.

[18]Zahw MAA. Development of testing framework for evaluation of rutting resistance of asphalt mixes. A Thesis submitted to the Faculty of Engineering,Al-Azhar University in fulfilment of the requirements for the degree of doctor of philosophy in Civil Engineering; 1996

[19]Tayfur S, Ozen H, Aksoy A. Investigation of rutting performance of asphalt mixtures containing polymer modifiers. Constr Build Mater 2007;21:328–37

[20]Tortum A, Celik C, Aydin AC. Determination of the optimum conditions for tire rubber in asphalt concrete. Build Environ 2005;40:1492–504.

[21]Siddique R. Recycled/waste plastic. Waste materials and by-products in,concrete. @Springer 2008. [chapter 3.[

[22] Li Y, White DJ, Lee Peyton R. Composite material from fly ash and postconsumer PET. Resour Conserv Recycl 1998;24:87–93.

[23]Bhikshma,V., Ravande,K., Nitturkar,K.,(2005).”Mechanical properties of fiber reinforced high

[24]strength concrete”,Recent advances in concrete and construction, Chennai,pp 23-33

[25]Roesler J., Bordelon A., Ioannides A., Beyer M., Wang D. (2008). “Design and Concrete MaterialRequirements For Ultra-Thin Whitetopping”. Illionoise Center for Transportaion.

[26]Permalatha, J., Govindraj, V., (2003). “Experimental studies on fiber reinforced concrete”proceedimg of the INCONTEST 2003, Coimbatore, 10-12 sept 2003, pp 462-468

[27]ArNON,B and Sidney M, (1990). “Fibre Reinforced Cementitious Composites”,Second edition.