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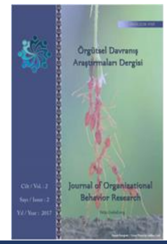

**New materials and the effect of added fiber material on the strength of concrete for runways and helicopter pads (new composite concretes)**

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***ABSTRACT***

*Concrete is one of the most widely used materials in the construction industry, so in recent years, the approach of construction industry experts has been focused on improving the quality of this product. One of the technical characteristics of concrete that has been considered by researchers in research is its compressive and tensile strength. To achieve this goal, in recent years, the use of less water to cement ratio with the help of superplasticizers, as well as the use of natural or synthetic pozzolans, as well as the use of fibers of different materials and specifications, in Concrete composition is common. Identifying the properties of concrete as one of the most widely used building materials has always been studied by many researchers. Compressive strength of concrete has been one of the characteristics that many experts have studied. Due to the current popularity of airport runways and helicopter pads, the need for final concrete coatings with the ability to accept heavy flights and wide-body aircraft using materials that have acceptable compressive and tensile strength has increased, in this way The use of composite concretes can be one way to meet this need. Our aim in this study is to investigate the effects of adding fibers of different materials on the strength properties of concrete.*

***Keywords:*** *High strength concrete, steel fibers, polypropylene fibers, glass fibers, runway, flight pad.*

## 1 - Introduction

At present, the reconstruction of the main runway of Shahid Madani Airport in Tabriz has been designed and executed using the 15-meter-wide and 4200-meter-wide Fenisher concrete method, which is capable of accepting wide-body flights up to B747 category. Traditional asphalt was applied with its final surface concrete, which in addition to greater compressive strength, will also be more resistant to the changing climate of the region. Similar to this plan, the construction of Ramsar airport runway and 29 right runway of Mehrabad airport has been approved by the pilots of this airport and according to related tests, the life of concrete pavement is between 40 to 45 years, while the life of traditional asphalt pavement is maximum 15 years.

Concrete is a combination of two components of aggregates with a matrix of cementitious materials whose cementitious materials can include natural or synthetic pozzolans. Therefore, it can be said that the ductility and strength properties of concrete made depend on the transition zone between the two (Brentson et al., 1990). With the use of most natural aggregates and controlled values of water to cement ratio, as well as the use of appropriate additives can be found in high-strength concretes (Mehta and Aitsin, 1990). However, today with the growth of concrete technology and the use of advanced types of new chemical additives, it is possible to achieve concretes with higher strength than conventional concrete. Concretes that were measured as high strength concretes fifty years ago are now known as low strength concretes.

For example, in the 1950s, concrete with a strength of 30 MPa and above was called high strength concrete, and this amount increased to about 40 to 50 MPa in the 1960s. In the 1970s, concretes with a strength of 60 MPa and above became known as high strength concretes, and in the 1980s, the strength of high strength concrete increased to 100 MPa and above. With the rapid development of concrete technology in recent years, in most parts of the world, concrete with a compressive strength of more than about 40 and 60 MPa is still known as high-strength concrete. In the American Concrete Institute standard, concrete with a compressive strength of cylindrical specimens over 40 MPa at the age of 28 days is defined as high-strength concrete (Committee 318 of the American Concrete Institute, 1999) and in some other standards this amount It is more than 60 MPa. Adding pozzolans to the concrete composition, in addition to reducing cement consumption and reducing environmental pollution, improves the performance and strength properties of concrete.

Other materials that improve the durability and strength properties of concretes and have been used in the composition of man-made mortars for a long time, are fibers of different materials and with different shapes. Fibers in concrete reduce the growth of primary fine cracks due to shrinkage and drying of concrete and with high elastic properties and tensile strength, improve the strength properties of concrete. Also, adding fibers in the concrete composition controls water absorption and reduces permeability in concrete. (Rama et al., 2010).

Destruction and deterioration of concrete is strongly dependent on the formation of cracks and microcracks due to loading or environmental influences. Heat and moisture changes in the cement paste cause fine cracks, and such fine cracks are concentrated on the surface of the coarse grains. With the greater impact of loading as well as other environmental issues, microcracks join together and form cracks, and finally these cracks spread in the concrete body [1]. The use of different fibers in concrete and the fabrication of fibrous concrete (FRC) is considered as an effective step in preventing the spread of microcracks and cracks and compensating for the weak tensile strength of concrete.

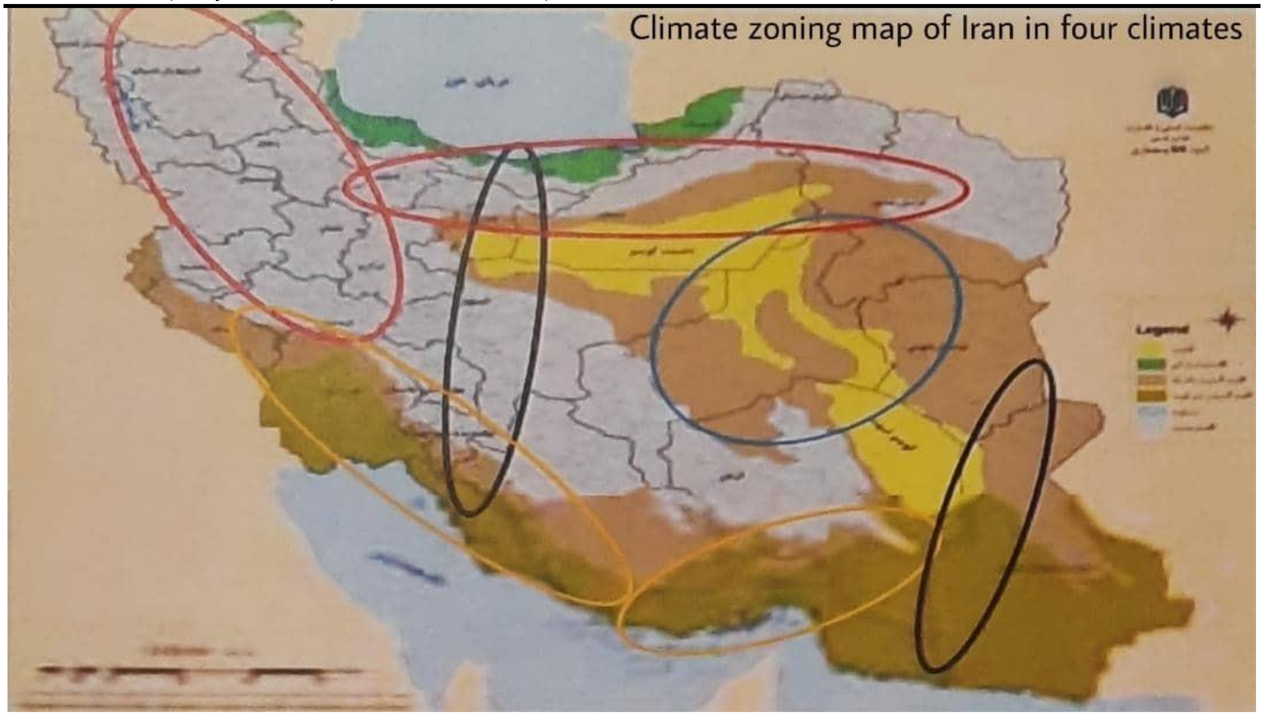
The most important characteristics of fiber concrete are its energy absorption, flexibility and impact resistance; For this reason, today, this concrete has played a very serious role in the development of concrete technology and is considered as a new and economical material in construction issues [2]. The energy absorption and strength properties of concrete can significantly reduce the risk of failure of concrete structures, especially in areas subject to repeated loads and seismic loads. The energy absorption properties of fibrous concrete are usually measured by a tensile test. In this test, the strength index "according to ASTM C1018 standard as the surface below the load curve - deformation of a standard beam with dimensions of 30 × 10 × 10 cm to a specific deformation (eg 3.5 times the deformation at the moment of the first crack), to the following level The same curve is defined until the deformation corresponding to the first crack, although the standard [544-ACI 4] provides a different definition from the previous definition for measuring the strength of fibrous concrete.

To clarify the ductility of fibrous concrete, note that the fracture strain of a brittle matrix (such as Portland cement) is far less than the fracture strain of a solid fiber (such as steel, glass, polypropylene, collar, etc.). As a result, when the fiber-reinforced cement is loaded, the matrix will crack much sooner than the fiber breaks. With matrix cracking, one of the following three types of failures may occur for a composite body: A. The composite body may break immediately after the matrix cracks, as in the case of low volume polymer fibers. B. The composite body may continue to withstand loads and deformations under lower loads, as in the case of low to medium volume steel fibers. In this case, the resistance after cracking is first provided by pulling the fibers out of the crack surface and then continues by deforming them. C. Even after the matrix cracks, the composite body may withstand more tensile stresses and deformations, such as when medium to high carbon fibers are used. Note that this only happens if the adhesion resistance of the filament at the moment of the first crack is greater than the load at the moment of the first crack, because at the moment of cracking the entire load is suddenly transferred to the fiber. Now, as the load on the composite body increases, the fiber transfers the extra stress to the matrix through adhesion. It is clear that among the above three cases, fiber concrete in position (a) has no ductility and the highest ductility is obtained for fiber concrete in conditions (c).

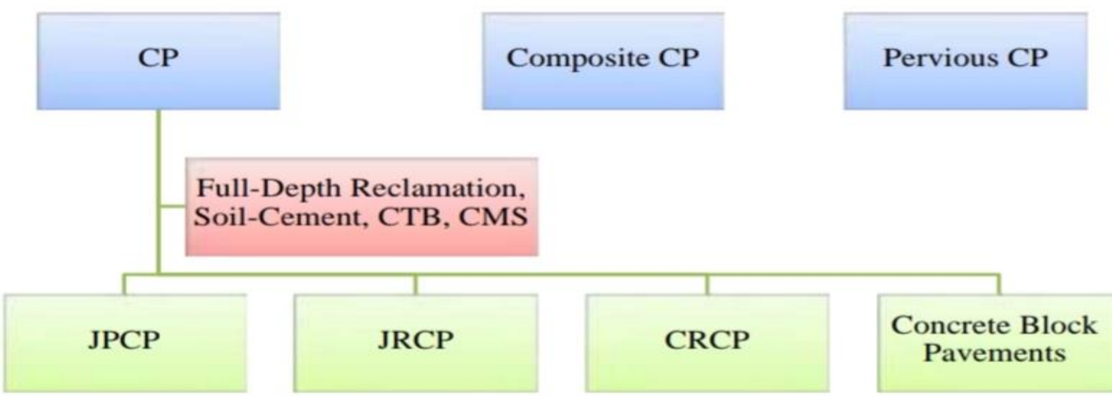
Fiber concrete is made with different fibers including steel, glass, carbon, aramid (Kevlar), polypropylene (PP), hemp and asbestos. Today, steel fibers are most commonly used in fibrous concrete, although other fibers may be used for specific reasons.

Concrete strength is usually the most important criterion used to evaluate the quality of concrete. Increasing the resistance over time is based on the continuity of cement dewatering and reducing the percentage of porosity and empty space between the components in the adhesion stage. The microsilica in concrete, which is a pozzolanic material, combines with the calcium hydroxide due to the hydration of the cement to form a gel-like composition. This compound is the main factor in increasing the strength and reducing the porosity of the particles that make up concrete. Large crystals of calcium hydroxide in the aggregate-paste joint prevent the increase in strength, which microsilica under pozzolanic reaction with calcium hydroxide converts into resistant components called hydrated calcium silicate, thus increasing the compressive strength of concrete.

In this research, after producing ordinary concrete and high-strength concrete, the effect of fibers of steel, glass and propylene on their performance and compressive and tensile strengths at 7 and 28 days of age has been investigated.




Potential of concrete application according to Irans climate www.cement review 1111-1




Types of concrete procedures and pavements

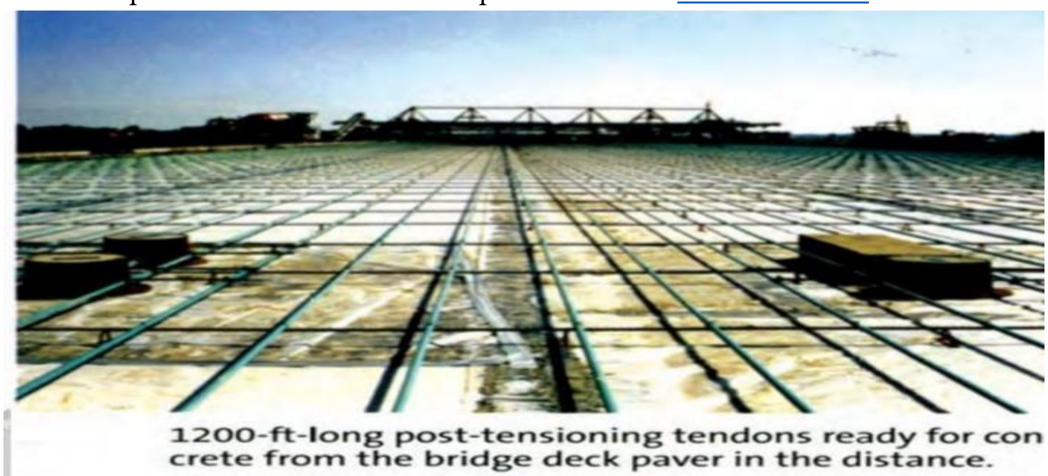
- Mehrabad airport 29 runway improvement project

* Executive operations in a 4,000-meter-long runway with a width of 60 meters (45meters main width in 9 lines of 5 meters with 15 meters of shoulder) and with 16 taxi ways perpendicular to the runway

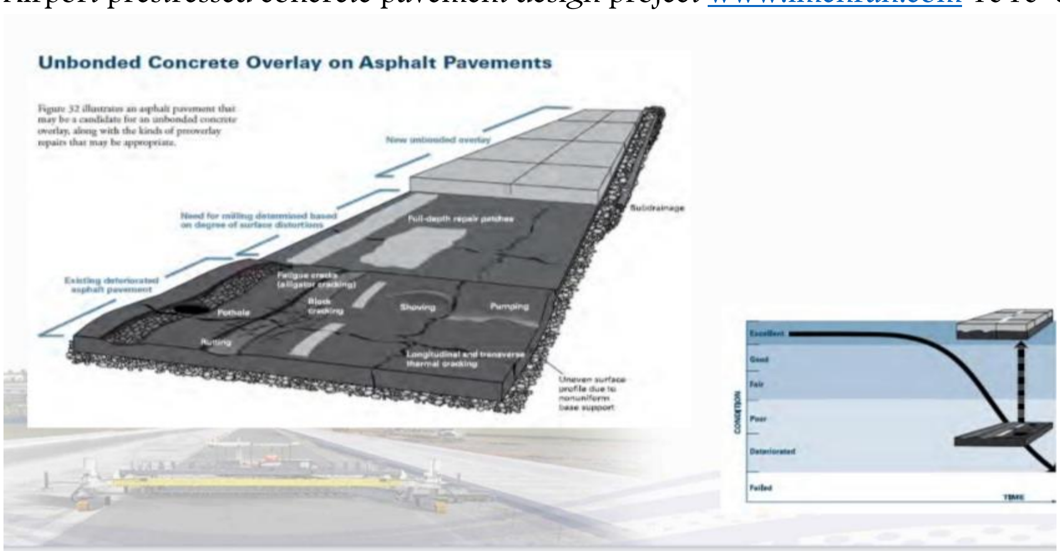
- * The initial condition of the pavement was all flexible pavement of asphalt concrete.
- * Following the selection of the Road, Housing and Urban Development Research Center by the parent company of the country's airports as the supreme supervisor of the project, the center was responsible for accepting all executive operations of the project as follows;
- * Asphalt laying of the main runway and creep runways (taxi way) in the amount of 180,000 cubic meters (in a runway with a length of 4000 meters and a width of 60 meters and 16 taxi ways perpendicular to the runway)
- * Execution of project bed construction operations in required locations Approximately 150,000 square meters
- * Execution of cement stabilization layer (FDR) operation in the amount of 70,000 cubic meters
- * Execution of concrete surface operations with paver in the amount of 110,000 cubic meters
- * Execution of soil strip operation in the amount of 350,000 square meters * Execution of underground drains and absorption trenches in each strip
- * Asphalt run over runway in the amount of 180,000 square meters


Concrete pavement of Mehrabad airport in Tehran www.imen rah.com 1010-01

Concrete pavement of Mehrabad airport in Tehran www.imenrah 1010-09




Airport prestressed concrete pavement design project www.imenrah.com 1010-05




Concrete cover
Brighter colors and colder

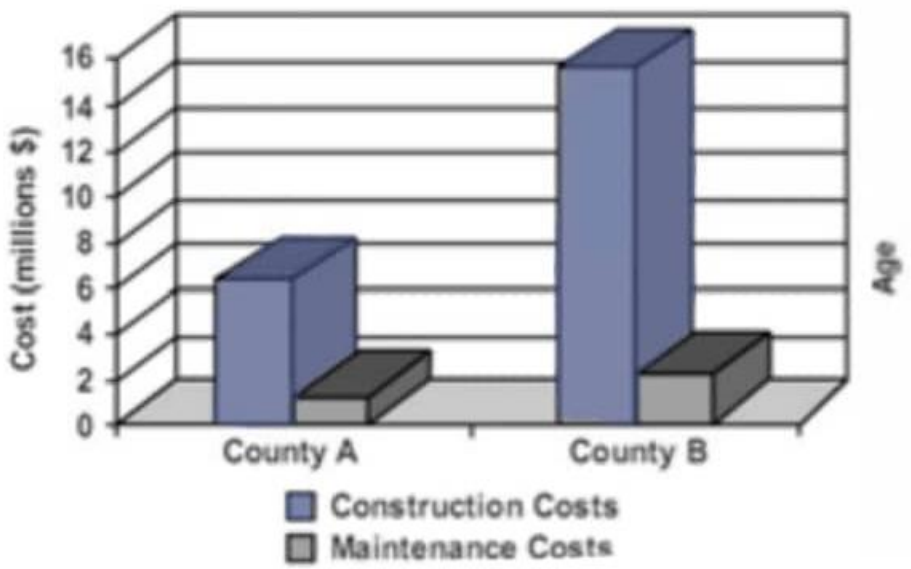
concrete surfaces reflect light. This feature reduces the energy required to light the road overnight. Lighting lights are important elements of urban highway facilities that directly improve traffic safety by enhancing night vision. Asphalt pavements require more lights per unit length to achieve illumination than concrete pavements. Studies show the results of cost savings of up to 31% in primary energy and lighting maintenance costs of concrete pavement versus asphalt pavement. Sunlight energy that is not reflected from the pavement is converted into thermal energy that raises the pavement temperature. Concrete pavement reflects more sunlight than asphalt pavement and is colder. Higher temperatures increase the formation of thick fog. Cooling a city only 5 degrees Celsius can have a dramatic effect on the concentration of fog. The use of lighter concrete pavements can have a good effect in this regard.

| Ratio of total lifetime costs of asphalt to concrete pavement | Ratio of total costs Total costs equivalent to longevity | Equivalent cost of renovation in year zero with discount rate of 5 (Rials) | Equivalent cost of maintenance in year zero with 5% discount plan (Rials) | Cost and initial construction (Rials) | Type of pavement | Bed support | Road category |
|---|---|---|---|---|---|---|---|
| 1.59 | 1297123171 | 385419190 | 67223781 | 844480200 | Concrete | Low | Low traffic highway |
| | 2063622889 | 803293125 | 380294265 | 880035500 | Asphalt | | |
| 1.54 | 1227035904 | 363455623 | 67223781 | 796356500 | Concrete | medium | |
| | 1887927712 | 719450477 | 380294265 | 788182970 | Asphalt | | |
| 1.70 | 1368993506 | 407941525 | 67223781 | 893828200 | Concrete | Low | Highway with medium traffic |
| | 2322336485 | 926752590 | 380294265 | 1015289630 | Asphalt | | |
| 1.66 | 1280938655 | 380347374 | 67223781 | 833367500 | Concrete | medium | |
| | [illegible] | [illegible] | [illegible] | [illegible] | Asphalt | | |
| 1.80 | [illegible] | [illegible] | 67223781 | [illegible] | Concrete | Low | Highway with high traffic |
| | [illegible] | [illegible] | [illegible] | [illegible] | Asphalt | | |
| 1.76 | [illegible] | [illegible] | 67223781 | [illegible] | Concrete | medium | |
| | [illegible] | 970794481 | 380294265 | [illegible] | Asphalt | | |

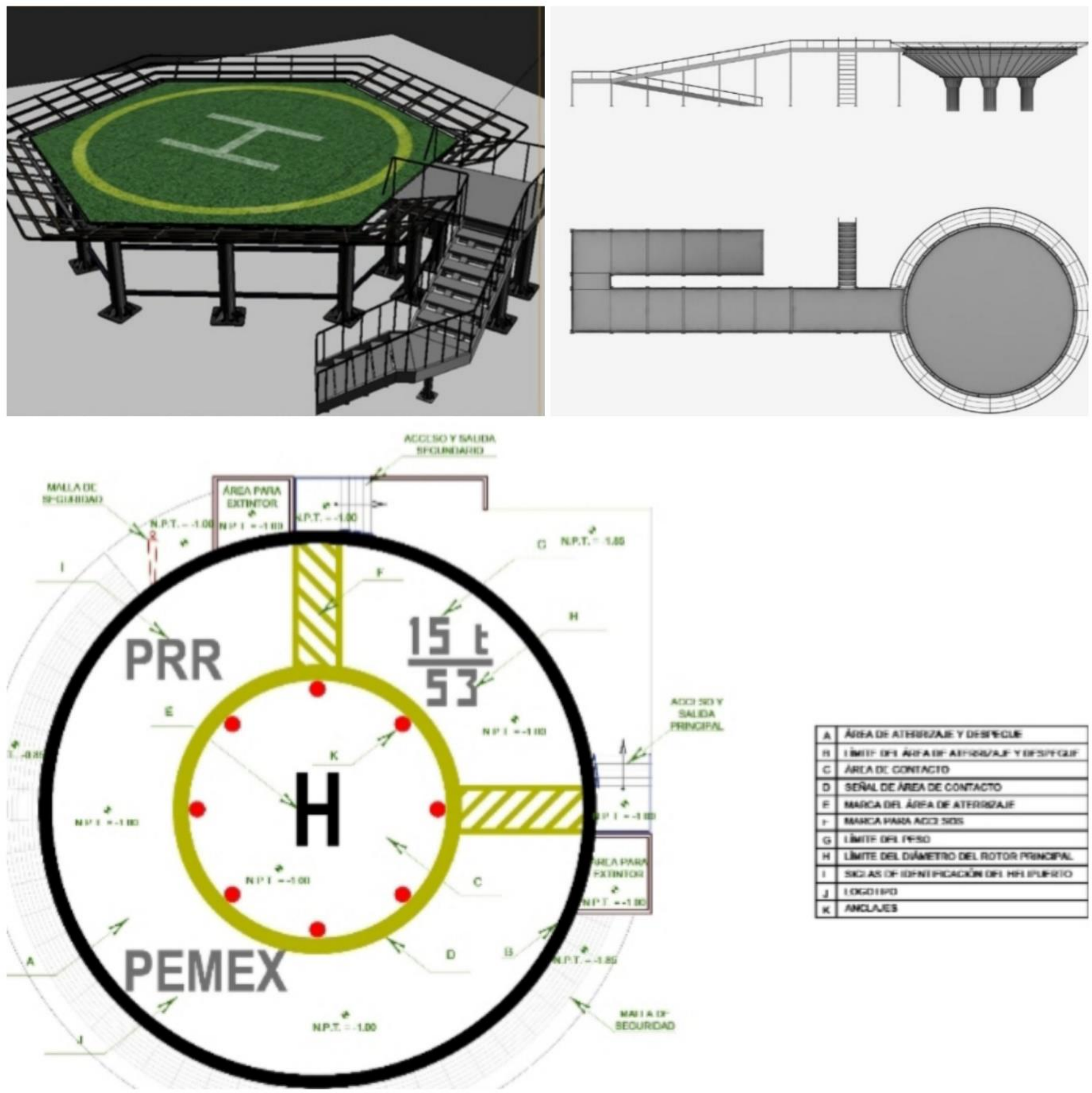
Comparison of lifetime costs of asphalt and concrete pavements one kilometer of the desired road

A study was conducted in the Iowa area on three areas to evaluate concrete and asphalt pavements from 1954 to 1994.

Zone A has concrete pavements, Zone B has asphalt pavements, and Zone C has almost equal pavements and asphalt pavements. . The results presented here focus on areas A and B. This figure shows the results for regions A and B. As can be seen, area A (concrete pavement) has lower construction and maintenance costs. In terms of performance, both systems performed well. Zone A (concrete pavement) has a pavement status index (PCI) of 97 (excellent) and zone B (asphalt pavement) has a pavement status index (PCI) of 84 (very good)




Comparison of service life




Helicopter pad standard specifications

1 - Introduction

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In this research, after producing ordinary concrete and high-strength concrete, the effect of fibers of steel, glass and propylene on their performance and compressive and tensile strengths at 7 and 28 days of age has been investigated.

## 2- Background review

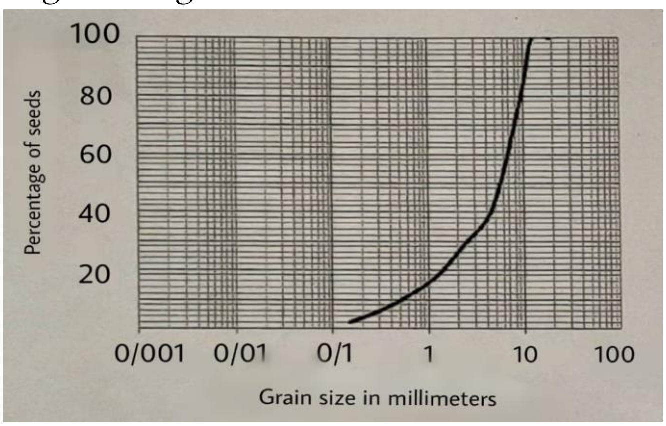
In a 1981 study of concrete reinforced with polypropylene fibers, Kobayashi and Chou showed that fiber reinforcement clearly increases strength, and that post-cracking behavior is strongly influenced by loading speed because it is a function of viscoelastic properties. It is a polypropylene fiber. In 1999 in the United States, the characteristics of microsilica concrete reinforced with polypropylene fibers were examined by HesamTo Tanji and it was found that the use of 5% microsilica with a volume ratio of 0.3% for restoration work from a perspective Resistance is the optimal mixing scheme. In 2002, Hanizam and Nordin studied the effect of alkali-resistant glass fibers on the compressive strength of lightweight concretes and concluded that there was a relationship between the amount of fibers used and the amount of compressive strength of fibrous concrete. By increasing the consumption of fibers in the composition of concretes from 0.2 to 0.6 by volume, they were able to increase the strength of concrete produced. In 2005, Noss and Fernandez increased the compressive strength by about 77 percent and the tensile strength by about 55 percent by using steel fibers in the composition of concretes containing superplasticizers as well as fly ash. In 2010, Chandramoli et al. Studied the strength properties of concretes containing glass fibers in different strength classes and found that consuming 0.03% by volume of glass fibers increased the compressive, tensile and flexural strength of concretes. Rama and Sudarsana in 2010 in a study entitled The effect of glass fibers on concretes containing fly ash were able to use fly ash and glass fibers to increase the compressive strength of concrete by about 20% at the age of 56 days. In 2012, Dashmukh et al. Studied the effect of glass fibers on concretes made using Portland cement and were able to consume 0.1% by volume of glass fibers in the composition of concrete, about 23% in compressive strength and 42%. Increase in tensile strength and 14% in flexural strength. In 2012, Kavita et al. Studied the behavior of glass and steel fibers on concrete and found that the compressive strength of fiberglass concretes made of steel or glass fibers had the same strength at 7 and 28 days of age. In 2012, Shend et al. Used steel fibers with different length to diameter ratios and concluded that by increasing this ratio from 50 to 67, the compressive and tensile strengths of the prepared specimens were reduced. Using the optimal amount of 3% by weight of steel fibers, they succeeded in improving the compressive and tensile strength properties of the concretes produced in their research. Tajan and Bahandari in a study in 2014 studied the effect of glass fibers on ordinary concrete and were able to consume 0.45% by volume of glass fibers in concrete at the age of 28 days, about 14% in compressive strength and 71% in strength Increase the tensile strength of concrete.

Javadi and Pourbaba have studied the effect of quartz powder on the compressive strength of high strength concrete using Azarshahr materials and the results show that the optimal ratio of microsilica and quartz powder is about 10 and 11% by weight of cement, respectively. In another study, Akbari et al. Obtained the optimal ratio of microsilica in increasing the compressive strength of concrete by 15%. Maleki and Ismaili studied the effect of microsilica products on the properties of hardened concrete and concluded that the use of microsilica products such as microsilica powder and gel has a compressive strength of 37 and. Increases by 5 and 56% [5]. Farrokhzad and Mehr Pouya have studied the use of microsilica and nanosilica to improve the mechanical properties and durability of self-compacting concrete containing aggregates obtained from concrete recycling and the results show that concrete samples with 15% microsilica have the highest average compressive strength and the lowest Are control examples. Ahmad Ardakani et al. Investigated the effect of microsilica on the compressive strength of concrete after fire and the research findings show that the best percentage of microsilica for concrete with the highest strength at 25 ° C is 8.7%, while with increasing The temperature of this percentage decreased and finally at a temperature of 1000 ° C to 5. It reaches 8%.

3 - materials and methods

1 – 3 - Materials

Cement: The cement used to produce concrete in this study was type 2 cement. Microsilica: As part of the cementitious materials in the mixing design, microsilica gel containing 92% silica was used. Mixture of aggregates used: The aggregates used in the production of concrete in this study were made of lime and broken and their granulation diagram is in accordance with the diagram of Figure 3-1.




The results of mechanical tests performed on aggregate materials are given in Tables 1-3 and 2-3.

| Unit weight of mass )(gr/cm3 | | Water absorption (%) | Needle aggregate (%) | Flaky aggregate (%) | model |
|---|---|---|---|---|---|
| Non condensing | compact | | | | |
| 1/39 | 1/53 | 0/83 | 12 | 9 | sand |

The results of mechanical tests on aggregate coarse . (1-3)

| Unit weight of mass )(gr/cm3 | | Absorption water (%) | ofSand equivalent (%) | Fineness modulus | model |
|---|---|---|---|---|---|
| Non condensing | compact | | | | |
| 1/72 | 1/86 | 1/04 | 75 | 3/51 | sand |

The results of mechanical tests on aggregate fine . (2-3)

Consumable superplasticizer:

Consumed superplasticizer is one of the basic superplasticizers based on polycarboxylate ether, which according to its instructions, is 0.8% by weight of cement used. Steel fibers: The length of these fibers is 50 mm and its diameter is 1 mm, so the ratio of length to diameter of these fibers is 50. Glass fibers: Glass fibers are used in combination with aluminoborosilicate in which the percentage of alkalis is 2%. According to the manufacturer of these fibers, their length is 20 mm and their diameter is 17 to 20 microns, and also the percentage of water absorption of these fibers is zero and their color is white. Polypropylene fibers: According to the manufacturer, the polypropylene fibers used are hydrophobic and have a zero water absorption percentage and are 25 mm long and 20 to 25 microns in diameter. The color of these fibers is also white.

2-3 - Method of mixing materials and sampling

Mixing materials was combined and performed in several stages with the help of an electric mixer. The method of mixing is that first, the aggregates are mixed in the mixer for two minutes and dry, then the fibers and some water are added gradually and during mixing, and in the next step, cement and microsilica are left with water and The superplasticizer was poured into the mixer at the same time and the materials were mixed for another 10 minutes. Mixing of materials in the manufacture of fiber-free concretes, as in the case of fiber-reinforced concrete, is done with the difference that there is no fiber in the mixing.

After mixing, the molding was done in standard cylindrical molds and the samples were vibrated, both internally using rods and hand hammers and externally with the help of electric vibrating table. The molded samples were removed from the molds after 24 hours and immersed in a pool of water and processed under standard conditions.

3 - 3 - Mixing designs

Fiberless concrete mixing design

To investigate the effect of different fibers, three modes were considered, the first mode is ordinary concrete and the second mode is the same concrete using superplasticizer and the ratio of water to cement is lower, which will be examined, and finally the third mode is the same made concrete It is in the second case, with the difference that microsilica is also used in its composition. Mixing designs of concretes made without the presence of fibers are in accordance with Table 3-3.

Table No. 3-3 - Concrete designs made without the presence of fibers.

| Plan | Water to cement ratio | Cement (Kg/m³) | water (Kg/m³) | Microsilica (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | Super lubricant (Kg/m³) | Fiber (Kg/m³) |
|---|---|---|---|---|---|---|---|---|
| C1 | 0/5 | 540 | 270 | 0 | 1050 | 800 | 0 | 0 |
| C2 | 0/3 | 540 | 162 | 0 | 1050 | 800 | 4/32 | 0 |
| C3 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 0 |

Fiber concrete concreting designs in high strength concrete, using three steel fibers and polypropylene and glass, with different amounts of consumption are given in Tables 3-4, 3-5 and 3-6.

Table 3-4 - Mixing designs of high strength concretes containing steel fibers.

| Plan | Water to cement ratio | Cement (Kg/m³) | Water (Kg/m³) | Microsilica (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | Super lubricant (Kg/m³) | Steel fibers (Kg/m³) |
|---|---|---|---|---|---|---|---|---|
| C3-S1 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 15 |
| C3-S2 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 20 |
| C3-S3 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 25 |
| C3-S4 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 30 |

Table No. 3-5 - Mixing designs of high strength concretes containing polypropylene fibers.

| Plan | Water to cement ratio | Cement (Kg/m³) | water (Kg/m³) | Microsilica (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | Super lubricant (Kg/m³) | Glass fiber (Kg/m³) |
|---|---|---|---|---|---|---|---|---|
| C3-P1 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 3 |
| C3-P2 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 4 |
| C3-P3 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 6 |
| C3-P4 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 8 |

Table No. 3-6 - Mixing designs of high strength concretes containing glass fibers.

| Plan | Water to cement ratio | Cement (Kg/m³) | water (Kg/m³) | Microsilica (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | Super lubricant (Kg/m³) | Glass fiber (Kg/m³) |
|---|---|---|---|---|---|---|---|---|
| C3-G1 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 2/70 |
| C3-G2 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 4/05 |
| C3-G3 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 5/40 |
| C3-G4 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 10/80 |
| C3-G5 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 16/20 |

Optimal fiber mixing schemes in high strength concretes

After performing the compressive and tensile strength tests on the samples obtained from high strength fiber concretes, from the results obtained which are mentioned below), the optimal amount of fiber consumption was determined according to Table 3. 7 is.

| Plan | Water to cement ratio | Cement (Kg/m³) | water (Kg/m³) | Microsilica (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | Super lubricant (Kg/m³) | Glass fiber (Kg/m³) |
|---|---|---|---|---|---|---|---|---|
| C3-P1 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 25 |
| C3-P2 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 5/4 |
| C3-P3 | 0/3 | 540 | 162 | 54 | 1050 | 800 | 4/32 | 6 |

Mixing plan of ordinary concrete and ordinary concrete containing superplasticizer

The mixing plan of ordinary concretes containing superplasticizers and the optimal amount of different fibers can be seen in Table 3-8 and the mixing plan of ordinary concretes containing the optimal amount of different fibers can be seen in Table 3-9.

Table No. 3-8 - Mixing designs of ordinary concretes containing superplasticizers and different fibers.

| Plan | Water to cement ratio | Cement (Kg/m³) | water (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | Super lubricant (Kg/m³) | fiber (Kg/m³) | Type of fibers |
|---|---|---|---|---|---|---|---|---|
| C2-S | 0/3 | 540 | 162 | 1050 | 800 | 4/32 | 25 | Steel |
| C2-G | 0/3 | 540 | 162 | 1050 | 800 | 4/32 | 5/4 | Glass |
| C2-P | 0/3 | 540 | 162 | 1050 | 800 | 4/32 | 6 | Polypropylene |

Table No. 3-9 - Mixing designs of ordinary concretes containing different fibers.

| Plan | Water to cement ratio | Cement (Kg/m³) | water (Kg/m³) | Coarse-grained aggregate (Kg/m³) | Fine-grained aggregate (Kg/m³) | fiber (Kg/m³) | Type of fibers |
|---|---|---|---|---|---|---|---|
| C1-S | 0/5 | 540 | 270 | 1050 | 800 | 25 | Steel |
| C1-G | 0/5 | 540 | 270 | 1050 | 800 | 5/4 | Glass |
| C1-P | 0/5 | 540 | 270 | 1050 | 800 | 6 | Polypropylene |

4- Results

The samples obtained from the concretes were broken after processing under standard conditions at the ages of 7 and 28 days in compressive strength and tensile strength tests. Tests to determine the strength of the samples were performed using a fully automatic digital hydraulic loading device that loaded at a constant speed of 0.24 MPa per second.

1-4 - Results of slump tests and compressive and tensile strength of fiber-free concretes

In Table 4-1, we see the results obtained from the slump tests and the compressive strength and tensile strength of concrete specimens made without fibers at the age of 7 days and 28 days.

Table No. 4-1 - Results of slump tests and compressive and tensile strength of fiber-free concretes.

| Plan | Description | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|---|
| | | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C1 | Free of microsilica and super-lubricant | 7 | 37 | 3/5 | 45 | 4/27 |
| C2 | No microsilica and has super lubricant | 12 | 43 | 4/12 | 65 | 6/83 |
| C3 | Contains microsilica and superplasticizer | 14/5 | 52/5 | 5/15 | 75 | 8/56 |

2- 4- The results of slump tests and compressive and tensile strength of high strength fiber concretes (to determine the optimal amount of fiber consumption)

The results of slip tests and compressive and tensile strength of high strength concretes containing steel fibers, at the ages of 7 and 28 days, are shown in Table 4-2.

Table No. 4-2 - Results of slump tests and strength of high strength concretes containing different amounts of steel fibers.

| Plan | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|
| | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C3-S1 | 12 | 53 | 5/47 | 76 | 9/14 |
| C3-S2 | 11 | 54 | 5/6 | 78 | 9/36 |
| C3-S3 | 10/5 | 54/6 | 5/65 | 78/7 | 9/6 |
| C3-S4 | 9/5 | 53/5 | 5/55 | 76/8 | 9/29 |

The results of slip tests and compressive and tensile strength of high strength concretes containing polypropylene fibers, at the ages of 7 and 28 days, are shown in Table 3-4.

Table No. 3-4 - Results of slump tests and strength of high strength concretes containing different amounts of polypropylene fibers.

| Plan | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|
| | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C3-S1 | 11/5 | 53/1 | 5/9 | 77/6 | 10/09 |
| C3-S2 | 11 | 54/4 | 6/1 | 80 | 10/8 |
| C3-S3 | 9/5 | 56 | 6/56 | 86 | 12/04 |
| C3-S4 | 9/5 | 53/5 | 6/25 | 83/5 | 11/69 |

The results of slip tests and compressive and tensile strength of high strength concretes containing glass fibers, at the ages of 7 and 28 days, are shown in Table 4-4.

Table No. 4-4 - Results of slump tests and strength of high strength concretes containing different amounts of glass fibers.

| Plan | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|
| | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C3-G1 | 14 | 53/8 | 6/1 | 76/1 | 9/6 |
| C3-G2 | 12/5 | 56/5 | 6/55 | 79/6 | 10/3 |
| C3-G3 | 11/5 | 58 | 7/16 | 80/5 | 10/87 |
| C3-G4 | 10 | 55/8 | 6/33 | 78/5 | 9/8 |
| C3-G5 | 8/5 | 54/6 | 6/17 | 77/3 | 9/6 |

3-4 - Results of slip tests and compressive and tensile strength of fibrous concrete in the optimal state of fiber consumption

The results of slip tests and compressive and tensile strength of high strength fiber concretes at the ages of 7 and 28 days are shown in Table 4-5.

Table No. 4-5 - Results of slump tests and strength of high strength fiber concretes.

| Plan | Type of fibers | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|---|
| | | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C3-S3 | steel | 10/5 | 54/6 | 5/65 | 78/7 | 9/6 |
| C3-P3 | Polypropylene | 9/5 | 56 | 6/56 | 86 | 12/04 |
| C3-G3 | Glass | 11/5 | 58 | 7/16 | 80/5 | 10/87 |

The results of slip tests and compressive and tensile strength of conventional fiber-reinforced concrete with superplasticizer at the ages of 7 and 28 days can be seen in Table 4-6.

Table No. 4-6 - Results of slump tests and resistance of conventional fibrous concrete containing superplasticizer

| Plan | Type of fibers | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|---|
| | | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C2-S | steel | 10/5 | 45/5 | 4/55 | 69 | 7/68 |
| C2-P | Polypropylene | 8 | 46/8 | 5/42 | 75 | 9/77 |
| C2-G | Glass | 10 | 48/5 | 5/9 | 70/5 | 8/9 |

The results of slip tests and compressive and tensile strength of ordinary fibrous concretes at the ages of 7 and 28 days are shown in Table 4-7.

Table No. 4-7 - Results of slump tests and strength of conventional fibrous concrete

| Plan | Type of fibers | Islamp (Cm) | 7 days | | 28 days | |
|---|---|---|---|---|---|---|
| | | | Pushing resistance MPa | Tensile strength MPa | Pushing resistance MPa | Tensile strength MPa |
| C2-S | steel | 6 | 39/5 | 3/9 | 48/1 | 4/85 |
| C2-P | Polypropylene | 5 | 40/8 | 4/7 | 52/5 | 6/3 |
| C2-G | Glass | 7 | 42/5 | 5/18 | 49 | 5/8 |

4-4- Compressive and tensile strength diagrams of concretes

Diagrams of compressive and tensile strength of fiber-free concretes can be seen in the diagrams of Figures 4-1 and 4-2.

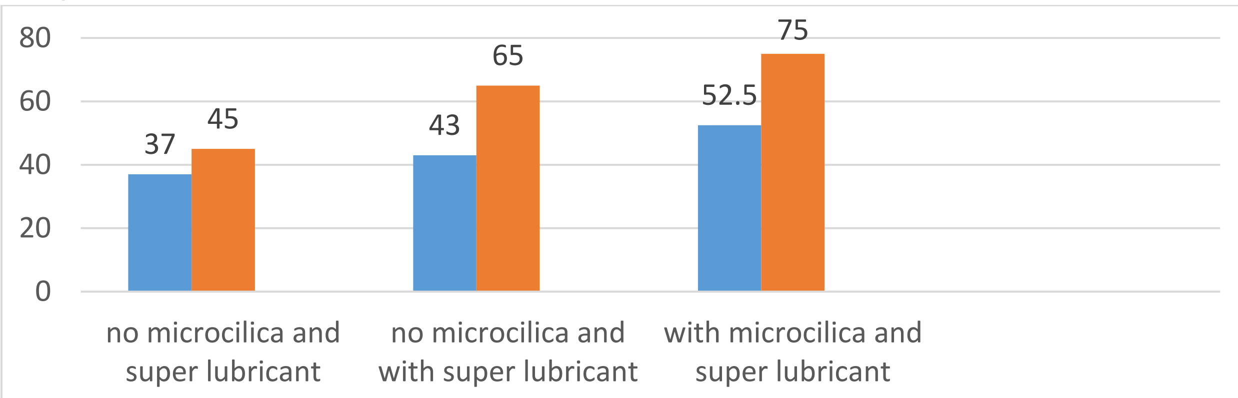



Figure 4-1 Compressive strength diagram of fiberless concretes at the ages of 7 and 28 days.

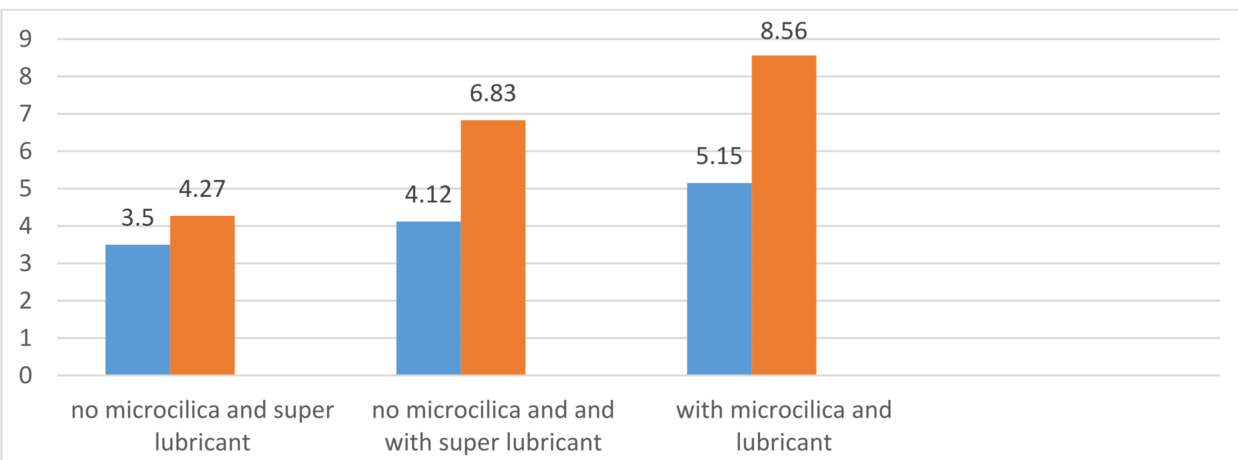
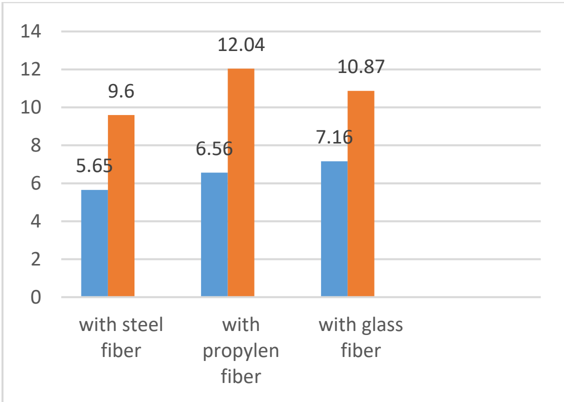
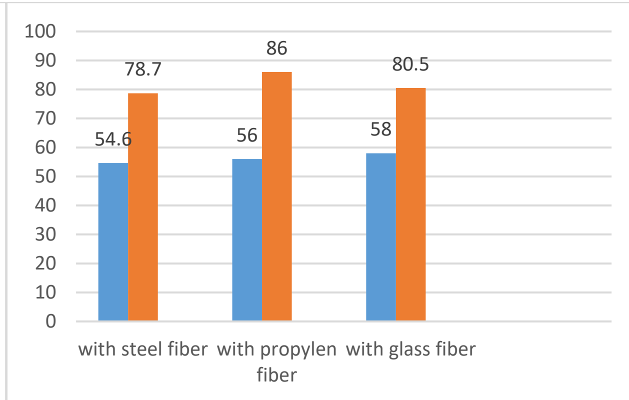



Figure 2-4 - Tensile strength diagram of fiberless concretes at the ages of 7 and 28 days.

Compressive and tensile strength diagrams of high strength fiber concrete are shown in Figure 3-4.

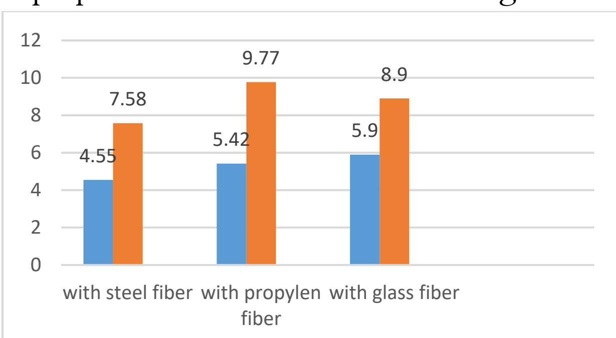


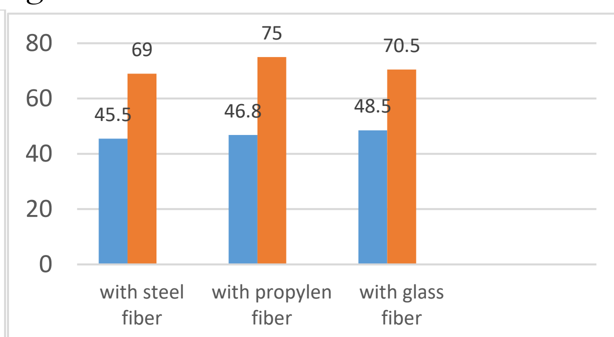




Tensile strength 7and 28 days (mega pascal) Compressive strength 7and 28 days (mega pascal)

Figure 3-4 - Compressive and tensile strength diagram of high strength fiber concrete at 7 and 28 days of age.

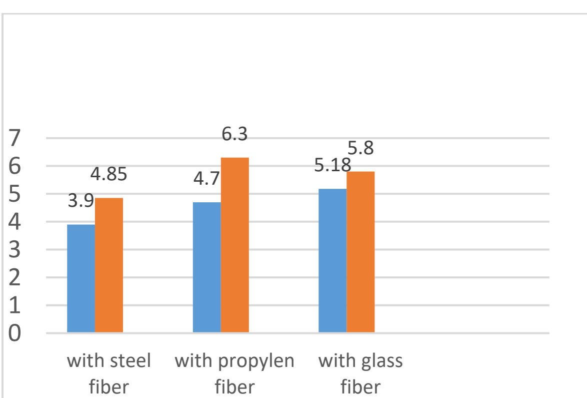
Compressive and tensile strength diagrams of conventional fibrous concrete containing superplasticizer can be seen in the diagrams in Figure 4-4.

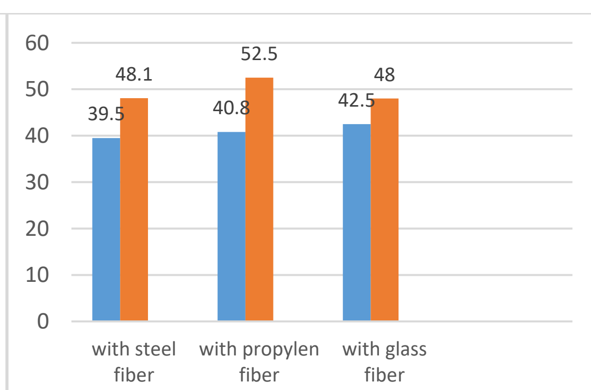



Tensile strength 7 and 28 days (mega pascal) Compressive strength 7 and 28 day (mega pascal)

Figure 4-4 - Compressive and tensile strength diagram of ordinary fibrous concrete containing superplasticizer at the ages of 7 and 28 days.




Tensile strength 7 and 28 days (mega pascal) Compressive strength 7 and 28 day(mega pascal)

Compressive and tensile strength diagrams of conventional fibrous concrete can be seen in the diagrams in Figure 4-5.

5- Conclusion

In this study, by reducing the ratio of water to cement in ordinary concrete, the water consumption is close to the amount of water required for cement hydration reactions and the cavities formed in concrete are reduced, resulting in increased concrete strength. It is noteworthy that super lubricant has been used to control the performance of concrete.

By adding microsilica in the composition of lime concrete produced in the process of hydration of cement, it reacts with the silica in microsilica and stabilizes the production of hydrated calcium silicate and increases the strength of concrete, while microsilica particles fill the space between aggregates and prevent them from locking. And thus the efficiency of concrete has increased. By adding fibers to concrete, the cohesion of concrete has increased and the efficiency of concrete has decreased. Also, by adding fibers in the composition of concretes, their compressive and tensile strength has been increased. It was related to polypropylene fibers and the lowest amount was related to steel fibers.

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