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Date palm fibers to improve tensile strength in self-compacting concrete with silica fume

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Abstract: Today, the use of new additives in self-compacting concrete leads to the improvement of its mechanical properties. Palm groves are one of the vegetation covers of behbahan city in iran, which cover a large area of land in this region. In this research, due to the abundance of palm groves in the south of iran, the idea of using date palm fibers in the self-compacting concrete mixing plan has been proposed. The fibers were cut into 3 cm lengths and used in self-compacting concrete as a natural, cheap and readily available admixture. In this research, palm fibers were used to make self-compacting concrete to improve the mechanical properties of this concrete with percentages of 0, 0.5, 1, 1.5, 2 weight percentage of cement. The results of the tests showed that the tensile strength of self-compacting concrete with and without date palm fibers with percentages of 0.5, 1, 1.5, 2 percent by weight of cement in 7 and 28 days of processing were 16.37%, 34.27%, 56.39%, 82.24% and 13.56%, 27.61%, 46.96%, 67.6% tensile strength increased compared to the self-compacting concrete sample without date fibers. The compressive strength of self-compacting concrete with and without date palm fibers with 0.5, 1, 1.5, 2 percent by weight of cement in 7 and 28 days of processing are 5.19%, 10.87%, 17.81%, 22.60% and 4.11%, 9.51%, 15.48%, 22.47% respectively of the compressive strength decreased compared to the self-compacting concrete sample without date fibers.

Keywords: self-compacting concrete, date palm fibers, compressive strength, tensile strength

1.Introduction

Self-compacting concrete is an important material in the construction industry (abani et al. 2018), which consists of fine and coarse aggregates (Alatshan et al. 2017), cement, additives and water (Al-Hadithi et al. 2023). Self-compacting concrete is widely used in the construction industry due to its advantages such as the availability of materials, smoothness and efficiency (Askar et al. 2023). The importance of self-compacting concrete is due to its high durability (Ayub et al. 2021), low cost in

implementation compared to ordinary concrete (Asmaa et al. 2022), its efficiency and resistance (Abdullah et al. 2023). One of the important characteristics of self-compacting concrete is its viscosity and stability compared to other types of concrete (Bozorgmehr Nia et al. 2022). This concrete is widely recommended in the construction of safe and durable structures that can withstand various loads (Bhat et al. 2023). In addition, self-compacting concrete can be considered a cost-effective material to reduce costs in implementation such as time and vibration due to compaction under its own weight (Dounia et al. 2023). This type of concrete flows easily in the mold, easily passes through the rebars (Djoudi et al. 2012), and under natural conditions (Dawood et al. 2010), it condenses under the effect of its own weight. This concrete has a very high efficiency (Daniyar et al. 2022).

The use of fibers in concrete has started four decades ago (Eskandari et al. 2021), and they are expanding in order to improve the properties and mechanical behavior of concrete (Falahtabar shiade et al. 2018). Fibers in concrete reduce the brittleness of concrete and ensure their plasticity (Fokam et al. 2020). Fibers may be vegetable (Ghobadi et al. 2019), synthetic or metallic (Irib News Agency et al. 2020). It improves the mechanical properties of concrete under compressive, tensile, bending, and shear loads (Jawad et al. 2021), as well as resistance to erosion, creep, shrinkage, freezing, wear, and erosion, and creates a unified material (Osama et al. 2021). Using waste in concrete mix is one of the effective ways to reduce waste materials (Jiaqing Wang et al. 2022). In addition, the use of waste materials as a substitute for part of cement in concrete mix design is an effective solution to solve environmental problems (Modarres et al. 2023). One of the natural fibers used in concrete is palm fiber (Mirabi Moghadam et al 2021). Considering that there are more than 45 thousand hectares of palm groves in khuzestan province (Mohan et al 2023), of this amount, there are more than 2 thousand hectares of palm groves in behbahan city (Nadhim et al 2022), so easy and cheap access to date palm fibers is possible in this region (Ramhormozy et al. 2020, Tawfeeq et al. 2022). Various researches have been conducted in relation to the use of palm fibers to improve the properties of concrete, some of which have been reviewed below:

investigated the estimation of mechanical properties and durability of self-compacting concrete with fibers using ultrasonic pulse speed (Falahtabar Shiade et al. (2018).

investigated cement mortar reinforced with plant fibers alpha, date and dis on the mechanical properties of concrete in the field of construction (Boutarfa et al. (2018).

investigated the flexural properties and tensile strength of concrete reinforced with palm fibers in the desert climate (Abani et al. (2018).

investigated cement mortar reinforced with natural fibers and palm kernel: study of mechanical properties (Fokam et al. (2020).

investigated the effect of the shape and amount of date palm sis fibers on the compressive and tensile strength of concrete (Mirabi Moghadam et al. (2021).

studied the effect of palm fibers and polypropylene on the characteristics of self-compacting concrete (Derdour et al. (2023).

studied the effect of recycled steel fibers from waste tires on concrete properties (Modarres et al. (2023).

One of the most important elements in the production of science is to consider the approach of sustainable development. Sustainable development with the concept of using existing potential and facilities and taking into account the needs of the future generation, in line with the optimal use of available natural resources, is important (Alatshan et al. 2017 and Abani et al. 2018).

Many researches have been done on the possibility of using plant waste in concrete to strengthen tensile and compressive strength. Natural fibers are one of the existing solutions that can be used as a substitute for common fibers in cement and concrete mortar (Hossein Bar et al. 2017 and Ghobadi et al. 2018).

The innovative aspect of this project is the optimal use of waste resources and minimizing waste and environmental pollution. Cement has tensile properties, but its tensile strength is very low compared to fibers. In order to reduce the amount of cement consumption in concrete and increase the tensile strength of concrete in the mixing design, palm fibers were used according to the weight of cement and silica fume and vma[1] to increase the strength and strengthen the transfer zone of concrete in this mixing design. The difference between this research and other researches is the use of microsilica gel and vma, which is an innovative aspect of this project.

In this article, the mechanical behavior and compressive and tensile strength of self-compacting concrete with palm fibers in behbahan region were investigated considering the weather conditions. The purpose and results of the tests increased the percentage of date fibers in self-compacting concrete and increased tensile strength. The compressive strength of the self-compacting concrete cube samples with 2% palm fibers decreased by 22.60% during the 7-day processing compared to the sample without palm fibers. Tensile strength of cylindrical self-compacting concrete samples with 2% palm fibers increased by 82.24% in 7 days of processing compared to samples without palm fibers.

2 .Laboratory program

2.1. Materials

2.1.1 .Cement

In all 5 mixed designs, Portland cement type 5 of Behbahan Cement Factory was used based on ASTM C150 standard (Portland Cement Standard Specifications. 2012). The specifications are shown in Tables 1 and 2.

Table. 1. Type 5 portland cement specifications

SO_3	MgO	CaO	Fe_2O_3	Al_2O_3	SiO_2	IR	**symbol**
0.50	2.28	64.64	5.40	4.40	21.38	0.18	**(%)**
C_4AF	C_3A	C_2S	C_3S	LOI	K_2O	O_2Na	**symbol**
16.42	2.52	15.23	61.12	0.19	0.77	0.26	**(%)**

Table. 2. Mechanical characteristics of type 5 portland cement

Final setup time (minutes) FST	Initial setup time (minutes) IST	Blaine's elegance (cm^2/g) BF	**standard levels**
260	155	3350	**standard**
28-day compressive strength (kg/cm^2)	7-day compressive strength (kg/cm^2)	3-day compressive strength (kg/cm^2)	**standard levels**
422	288	224	**standard**

2.1.2. Date palm fibers

Date palm fibers are obtained by separating two parts. First, the palm fiber should be separated from the main trunk of the palm (according to figure 1), then the fiber should be cut and the broken fibers should be created with a suitable length of 3 cm as a natural, cheap and accessible additive. It can be used in different weights in self-compacting concrete (according to figure 2).

[1] Viscosity Modifying Admixtures

Fig. 1. Behbahan date palm

Fig. 2. Palm fiber components

According to Table 3, the specifications of date fibers have been determined for the mixed design (according to figures 3).

Table. 3. Characteristics of date palm fibers (Falahtabar Shiade et al. (2018) - (Mirabi Moghadam et al. (2021) - (ASTM C496 Tensile Concrete Test Equipment.2002)).

Characteristics	Fiber diameter (mm)	Maximum tensile strength (MPa)	Modulus of elasticity (MPa)	Special Weight (gr/cm^3)	Extension (24 hours)	Cross section increase (24 hours)
amount of	0.50	70.59	780.60	0.80	10.19%	1.94%
Characteristics	**Water absorption (24 hours)**	**Thermal conductivity coeficient**	**Thermal conductivity (W/m.K)**	**Specific heat (Kj/k) capacity**	**Thermal emission rate (mm^2/s)**	**Natural humidity percentage**
amount of	162%	0.045%	0.060	1.26	0.83	1.96

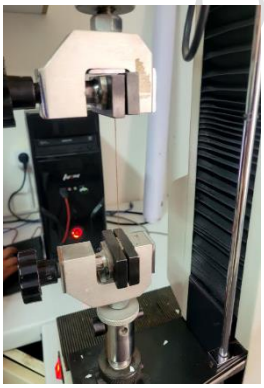

Fig. 3. Tensile test of date fibers with bongshin device to determine tensile strength

The values mentioned in Table 3 may be different depending on the type of palm fibers of each region and the test conditions used. However, in general, palm fibers have good thermal insulation properties, and due to their low thermal conductivity, they can have different applications for temperature regulation and prevention of heat loss in concrete. The elemental composition of date palm fibers was investigated by SEM analysis, which indicates the presence of silicon dioxide in its composition. This element is effective in the mechanical properties of self-compacting concrete (according to figure 4). According to the tensile test results of date palm fibers, male palm fibers have the highest tensile strength compared to female date palm fibers, and male date palm fibers were used for this project.

Element	Weight%	Atomic%
C K	49.81	57.67
O K	47.48	41.27
Si K	0.76	0.38
Ca K	1.95	0.68
Totals	100.00	

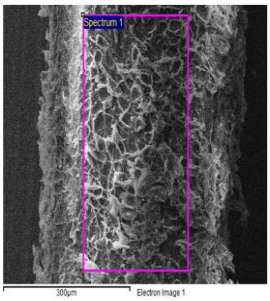

Fig. 4. SEM[2] analysis of date palm fibers

2.1.3. Aggregates

In this mixed design, coarse aggregate with a maximum size of 19 mm and sand with a maximum size of 4.75 mm is used. The sand used in this design is mixed from ramhormoz, khuzestan. Gravel (peas, almonds) and sand were granulated using a suitable sieve. For pea sand passed through 8/3 sieve, almond sand passed through 1/2 sieve and sand passed through 8 sieve were used, which conforms to ASTM C33 (Standard Specification for Concrete Aggregates. 2003). (According to Table 4 and figure 5).

Table. 4. Characteristics of aggregates

Water absorption percentage of almond sand	Water absorption percentage of pea sand	Sand water absorption percentage	**Characteristics**
0.90	0.80	2.2	**(%)**

Fig. 5. gravel (peas and almonds) and washed sand

2.1.4 .superplasticizer and silica fume

in order to achieve the mechanical properties of self-compacting concrete, super plast pc5000, which is made on the basis of polycarboxylate, was used as a type of water reducing and reinforcing concrete. Also, to achieve rheological properties in the pasty state and improve the quality of self-compacting concrete, silica fume was used, which is based on silica fume and is a strong reducer of concrete water. The use of silica fume increases the compressive strength, reduces the permeability of concrete and eases concreting by increasing concrete slump and high efficiency. Also, silica fume can strengthen the transition zone and affect the final strength of concrete. It is in accordance with ASTM C 494 (Standard Specification for chemical additives for Concrete. 2002) (according to Table 5).

Table. 5. Technical specifications of superplasticizer and silica fume

Special Weight (kg/m^3)	Color	PH	Specific gravity (kg/liter)	physical condition	**Characteristics**
SUPER PLAST PC5000 superplasticizer					
1.008	yellow	6.2	1.1	liquid	**General**
silica fume					
320	Gray	9	1.35	thick liquid	**General**

2.1.5 .Water

The water used in the self-compacting concrete mix design is potable water. It was used to produce and process the samples, which conforms to the requirements of ASTM C 94 (Standard specification for Ready-Mixed Concrete. 2009) (according to Table 6).

Table. 6. Characteristics of drinking water

Chloride ion concentration	pH	temperature (℃)	**Characteristics**
50	6	20	**amount of**

2.1.6 . Limestone powder

One of the necessary materials to ensure proper viscosity in self-compacting concrete is stone powder. Due to the presence of very fine particles, fillers such as stone powder fill the voids and voids between the cement and aggregate particles and therefore reduce the porosity and increase the bulkiness of concrete. This category of filler elements, due

[2] A scanning electron microscope or SEM is a type of electron microscope capable of photographing surfaces with a magnification of 10 to 500,000 times with a resolution of less than 1 to 20 nm (depending on the type of sample).

to having a very high specific surface area, increases the friction between grains and increases the viscosity of concrete, therefore, the use of super-lubricants in order to increase the fluidity of concrete in the construction of such concrete. It is inevitable. The results of chemical analysis and physical characteristics of cement and limestone powder are shown in Table 7. In this design, Qom limestone powder was used.

Table. 7. Qom limestone powder

LOI	SO_3	Cao	MgO	Fe_2O_3	Al_2O_3	SiO_2	**Characteristics**
43.2	1.24	51.22	1.8	0.50	0.35	2.8	**(%)**

2.1.7 .VMA (solidifier and controller of concrete rheology)

VMA powder additive is developed to produce self-compacting concrete with increased viscosity and controlled rheological properties. VMA plays a significant role in controlling excess water in concrete. In this research, the Master Matrix VMA 358 additive was used based on heavy polymer molecular strands with extraordinary stability. The amount of this material in the concrete mix plan is calculated in relation to the percentage of cement. When all the ingredients were mixed in the mixer. At the last moment when the concrete is formed, the mixer is turned off for a few seconds and the concrete is allowed to rest. A certain amount of VMA is spread on the concrete so that the excess water in the concrete is controlled through VMA and the concrete becomes fluid and more efficient, which is in accordance with the ASTM C 494/C 494M standard (Standard specification for chemical admixtures for concrete 2002) (according to figure 6).

Fig. 6. VMA (solidifier and controller of concrete rheology)

2.2 .Mixed design

5 mixing plans of self-compacting concrete with date palm fibers were investigated in this research. The percentage of date fibers is in different ratios (0%, 0.5%, 1%, 1.5%, 2% weight percentage of cement). In all 5 mixed designs, the amount of materials is constant and the percentage of date palm fibers is variable (according to Table 8).

Table. 8. Mixing design of self-compacting concrete with and without date palm fibers (Kg/m^3)

Superplasticizer	palm fibers	VMA	Stone powder	silica fume	Water	sand	Almond sand	Pea sand	Cement
Self-compacting concrete without date palm fibers (0%)									
10	-	0.160	160	5	135	1240	150	300	400
Self-compacting concrete with palm fibers (0.5%)									
10	2	0.160	160	5	135	1240	150	300	400
Self-compacting concrete with palm fibers (1%)									
10	4	0.160	160	5	135	1240	150	300	400
Self-compacting concrete with palm fibers (1.5%)									
10	6	0.160	160	5	135	1240	150	300	400
Self-compacting concrete with palm fibers (2%)									
10	8	0.160	160	5	135	1240	150	300	400

2.3 .Doing experiment

To achieve the right mixing plan, first, different combinations of benefits such as; Cement, sand, gravel (peas, almonds), water, Superplasticizer, microsilica, rock powder, date palm fibers and VMA were mixed together in a mixer in suitable and uniform

environmental conditions, and as a result, self-compacting concrete with and without date palm fibers was produced. For the benefits mixture, the mixer was used for 8 minutes to prepare self-compacting concrete with and without fibers. The order of pouring benefits in the mixer is as follows:
First, gravel (peas and almonds) and sand ASTM C33 (Standard Specification for Concrete Aggregates. 2003) were added in the mixer for 1 minute, then stone powder and date palm fibers were added to the mixture for 3 minutes and mixed in the mixer, in the next step cement ASTM C150 standard (Standard Specification for Portland Cement. 2012), water ASTM C 94 (Standard specification for Ready-Mixed Concrete. 2009), Superplasticizer, microsilica ASTM C 494 (Standard Specification for Chemical Additives for Concrete. 2002) and VMA ASTM C 494/C 494M standard (Standard specification for chemical admixtures for concrete 2002) Add in the mixer and mix for 4 minutes to produce self-compacting concrete.
After mixing the mentioned materials in the mixer, slump flow test (Standard Test Method for Slump Flow of Self-Consolidating Concrete, 2009), V-Funnel test (Self-compacting concrete V-funnel test 2013), L-Box test (Self-compacting concrete-L box test 2013), J-Ring test (self-consolidating concrete by J-ring- Test Method 2014) are necessary for the properties of fresh-self-compacting concrete with and without palm fibers.

2.3.1 .Slump flow test

Slump flow test is very common to determine the efficiency of self-compacting concrete due to its simplicity. The slump flow test is based on the ASTM C1611 standard (Standard test method for slump flow of self-Consolidating Concrete, 2009).

2.3.2 .V-Funnel test

The V-Funnel test is performed to measure the ability of self-compacting concrete to change the flow direction and pass through the reinforced and bound sections, without separating the grains and blocking the flow. V-funnel tests are in accordance with the ISIRI 3203-9 standard (Self-compacting concrete V-funnel test 2013).

2.3.3 .L-Box test

The purpose of the L-Box test is to check the fluidity, the strength of the concrete passing between the rebars, the stability against the separation of the grains and the filling ability. The L box test is in accordance with the INSO 3203-10 standard (Self-compacting concrete-L box test 2013).

2.3.4 .J-Ring test

The J-Ring test actually simulates the passage of concrete through rebars and is used to check the ability to pass. The J ring test is in accordance with the INSO 11271 standard (self-consolidating concrete by J-ring- Test Method 2014).

2.4 .Molding of concrete samples

Fresh self-compacting concrete was poured into cubic molds with dimensions of 150 × 150 × 150 mm and cylindrical molds with dimensions of 150 × 300 mm and molded. They were kept at a temperature of 25°C for 24 hours to harden, and after 24 hours, the samples were taken out of the molds and kept in a water tank for curing for 7 and 28 days. A total of 300 self-compacting concrete samples were made with and without date palm fibers. Of these, 150 specimens were made in a cube mold and 150 specimens were made in a cylindrical mold. After the 5 mix design reached the ages of 7 and 28 days, the compressive strength test of cubic specimens was performed according to the ISIRI 3206 standard (Standard Test Determining the compressive strength of concrete samples, 2003) and the tensile strength test of

cylindrical specimens was performed according to the ASTM C496 standard (ASTM C496 Tensile Concrete Test Equipment.2002). A concrete breaker jack was used to break the concrete samples. Finally, after the failure test of the concrete samples, the results of the samples were compared and analyzed with (self-compacting concrete without fibers).

3 .Testing the compressive strength of cubic specimens

The results of compressive strength tests of concretes based on the age of 7 and 28 days with cubic dimensions of 150×150×150 mm on cubic test pieces according to the ISIRI 3206 standard (Standard Test Determining the compressive strength of concrete samples, 2003) showed that by adding date palm fibers to self-compacting concrete, The compressive strength decreases (according to figures 7).

Fig. 7. The failure of the cube specimen with the compressive strength device and the specimen broken with palm fibers

4 .Testing the tensile strength of cylindrical samples

The tensile strength of concretes based on the age of 7 and 28 days with cylindrical dimensions of 150 × 300 mm were investigated. The results of tests on cylindrical specimens based on the ASTM C496 standard (ASTM C496 Tensile Concrete Test Equipment.2002) showed that the tensile strength increases with the addition of date palm fibers to self-compacting concrete (according to figures 8).

Fig. 8. Failure of the cylindrical test piece with the Brazilian device and the test piece broken with palm fibers

5. Results and interpretation

5.1. Slump flow test

The results of the slump flow test showed that with the increase in the percentage of date palm fibers in the self-compacting concrete, the slump diameter decreased and the time also increased, which indicates a decrease in concrete flow. This issue is in accordance with the standard ASTM C1611 (Standard Test method for slump Flow of Self-consolidating concrete 2009).

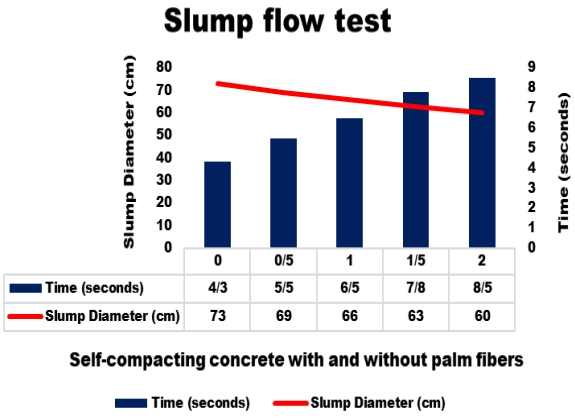

Fig. 9. Slump flow test results

5.2. V-Funnel test

The results of the V-Funnel test showed that with the increase in the percentage of date palm fibers, the test time increased, which indicates that the concrete becomes harder and its flow decreases with the increase in the percentage of date palm fibers, which is in accordance with the ISISIR 3203-9 standard (Self-compacting concrete V-funnel test 2013).

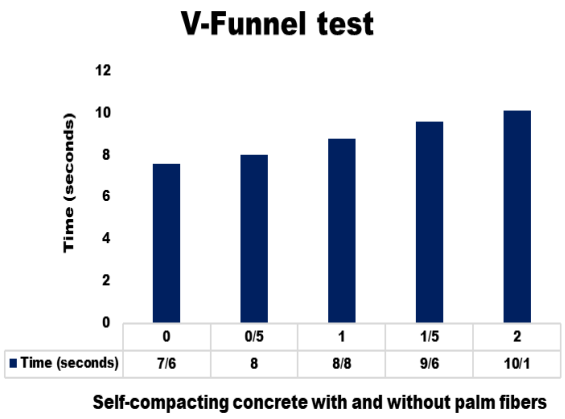

Fig. 10. V-Funnel test results

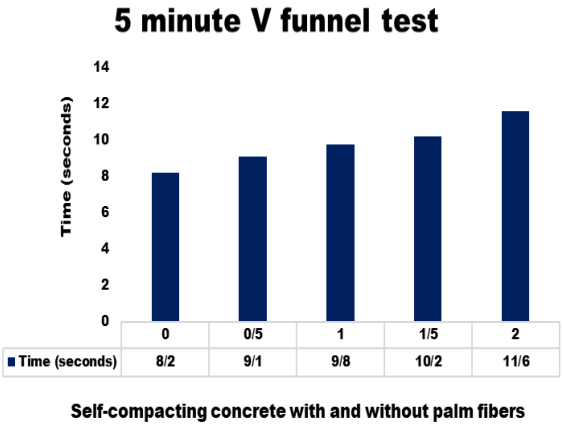

Fig. 11. results of the 5-minute V-Funnel test

5.3. L-Box test

The results of the L-Box test showed that with the increase in the percentage of date palm fibers, the test time increased and the height of the edge of the box to the vertical surface and the height of the edge of the box to the horizontal surface decreased, which is in accordance with the INSO 3203-10 standard (Self-compacting concrete L-box test 2013).

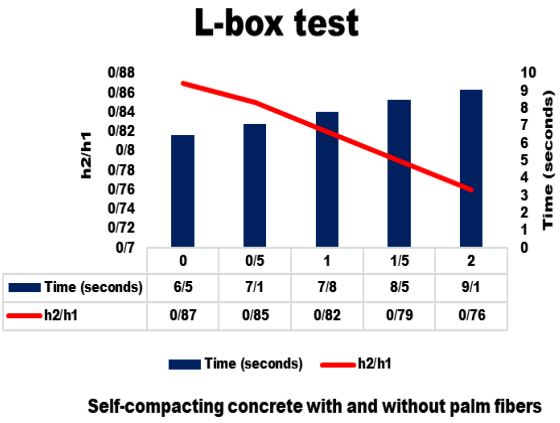

Fig. 12. L-Box test results

5.4. J-Ring test

The results of the J-Ring test showed that with the increase in the percentage of date palm fibers, the test time increased and the diameter of the slump decreased, which is in

accordance with the INSO 11271 standard (self-consolidating concrete by J-ring- Test Method 2014).

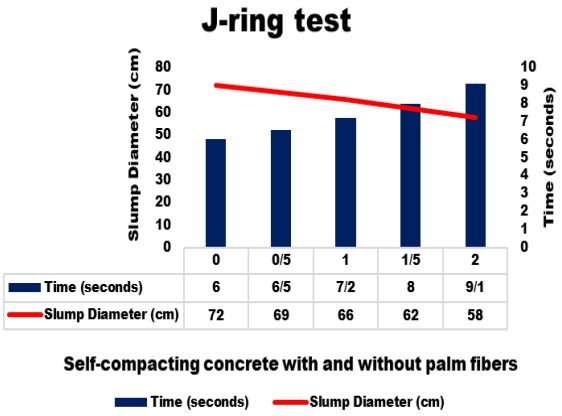

Fig. 13. J-Ring test results

5.5. Testing the compressive strength of cubic specimens

The reason for the decrease in compressive strength in self-compacting concrete for cubic samples is due to the negative effect of the empty space created in self-compacting concrete due to the amount, shape and dispersion of fibers in concrete. Also, by increasing the percentage of date palm fibers, it causes a decrease in porosity due to the addition of fibers and, as a result, a decrease in adhesion between cement and aggregates, a decrease in adhesion in the concrete transition area, and a lack of cohesion for sufficient concrete durability.

Table. 9. Recorded results of compressive strength test data for cubic samples (MPa)

5	4	3	2	1	No
(SCCPF 2%)	(SCCPF 1.5%)	(SCCPF 1%)	(SCCPF 0.5%)	(SCC 0%)	Type of concrete
Compressive strength test results in 7-day curing for cubic samples (MPa)					
28.82 – 30	29.52- 30.10	30.57 – 32.72	31.37 - 34.15	32.71 – 34.8	Data range
29/41	30/44	31/63	32/65	33/67	Average
0/1160	0/1647	0/4490	0/6590	0/5432	Variance
0/3406	0/458	0/6701	0/8118	0/737	standard deviation
0/0115	0/015	0/0211	0/0248	0/0218	Coefficient of variation
Compressive strength test results in 28-day curing for cubic samples (MPa)					
34.72 – 35.98	35.87 – 37.31	37.37 – 38.80	38.28 – 39.81	40.04 –41.58	Data range
35/49	36/76	38/19	39/12	40/75	Average
0/1852	0/2278	0/1929	0/2671	0/3034	Variance
0/4303	0/4773	0/4392	0/5168	0/5522	standard deviation
0/0121	0/0129	0/0114	0/0132	0/0135	Coefficient of variation

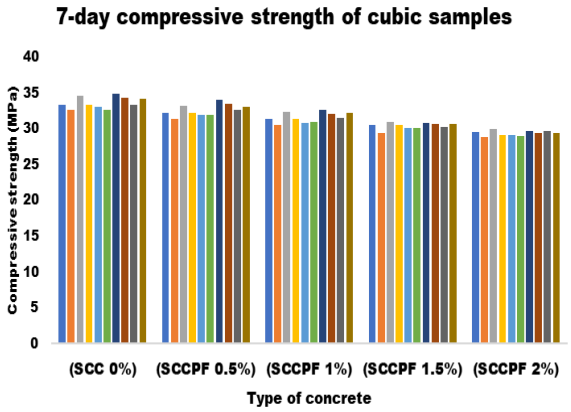

Fig. 14. 7-day compressive strength results of cubic samples

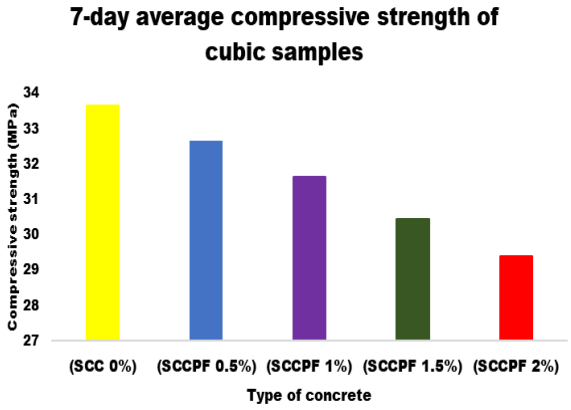

Fig. 15. results of the 7-day average compressive strength of cubic samples

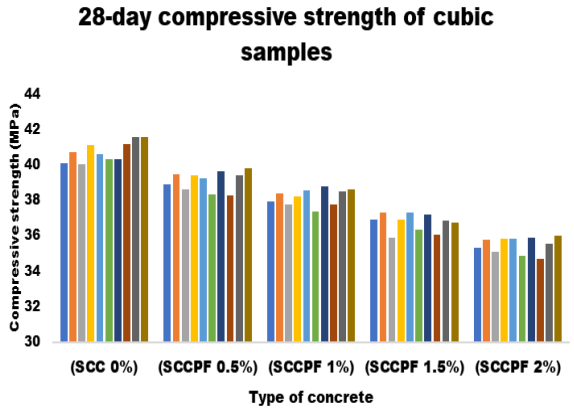

Fig. 16. 28-day compressive strength results of cubic samples

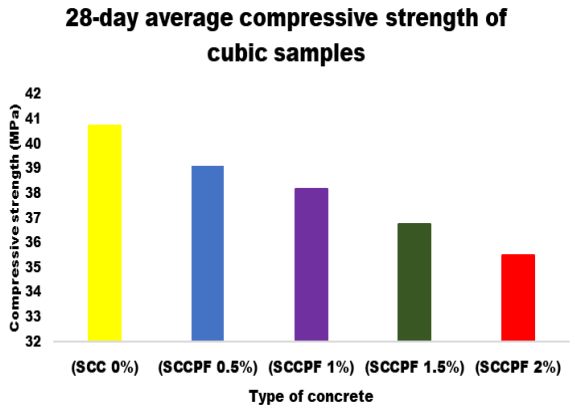

Fig. 17. results of the 28-day average compressive strength of cubic samples

5.6. Testing the tensile strength of cylindrical samples

The reason for the increase in the tensile strength test of self-compacting concrete for cylindrical specimens is due to the positive effect of the unique characteristic of fibers with regard to the tensile strength and modulus of elasticity of date palm fibers in self-compacting concrete due to the quantity and size.

Table. 10. Recorded results of tensile strength test data for cylindrical samples (MPa)

No	Type of concrete	1 (SCC 0%)	2 (SCCPF 0.5%)	3 (SCCPF 1%)	4 (SCCPF 1.5%)	5 (SCCPF 2%)
Tensile strength test results in 7-day curing for cylindrical samples (MPa)						
Data range		12.10 – 12.9	14.30 - 14.96	16.20 – 17.05	19.30 - 19.80	22.50 – 23.10
Average		12/525	14/61	16/748	19/6	22/831
Variance		0/0494	0/04194	0/05203	0/02346	0/02470
standard deviation		0/222	0/204	0/2281	0/1531	0/1571
Coefficient of variation		0/017	0/0140	0/0136	0/0078	0/0068
Tensile strength test results in 28-day curing for cylindrical samples (MPa)						
Data range		14.2 – 15.1	16.23 – 17.2	18.5 – 19.2	21.3 – 22.63	24.1 – 24.96
Average		14/671	16/587	18/769	21/677	24/731
Variance		0/0875	0/0650	0/0466	0/1232	0/0578
standard deviation		0/2958	0/255	0/216	0/3511	0/2404
Coefficient of variation		0/0201	0/0153	0/0115	0/0161	0/0097

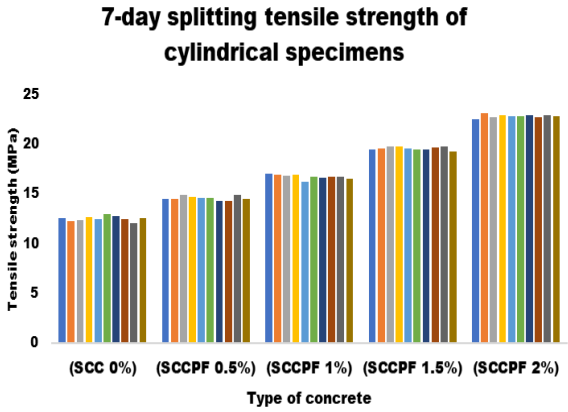

Fig. 18. 7-day splitting tensile strength of cylindrical specimens

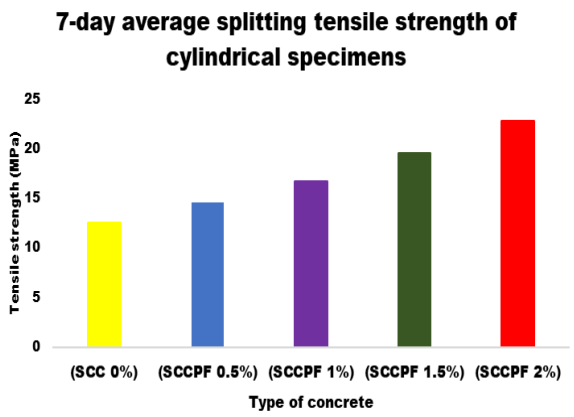

Fig. 19. results of the 7-day splitting tensile strength of cylindrical specimens

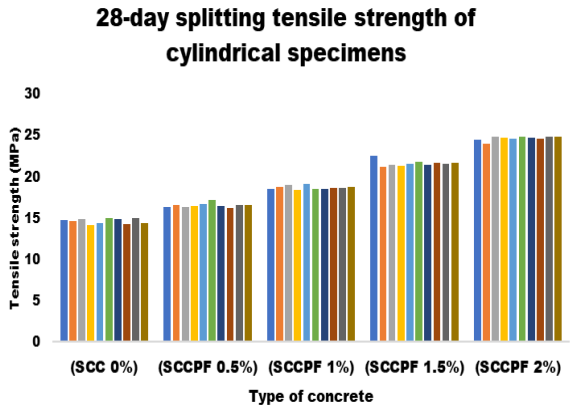

Fig. 20. 28-day splitting tensile strength of cylindrical specimens

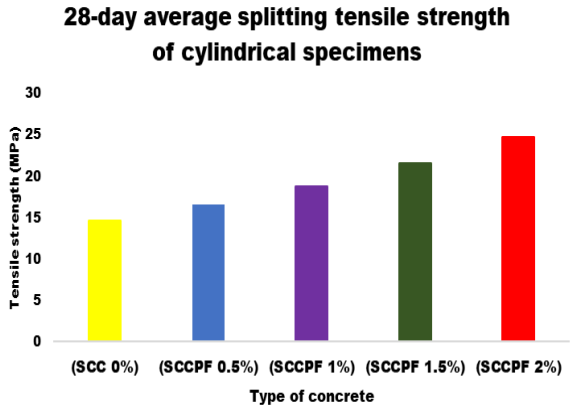

Fig. 21. results of the 28-day splitting tensile strength of cylindrical specimens

According to the background of the research in mirabi moghadam's research in 2021, with an increase of 2% of date palm fibers in concrete, the tensile strength increased, according to the results of our research, with an increase of 2% of date palm fibers in self-compacting concrete, the tensile strength increased. In the research of Falahtabar Shiade in 2018, the compressive strength decreased with an increase of 2% of date palm fibers in concrete. According to the results of our research, the compressive strength decreased with an increase of 2% of date palm fibers in self-compacting concrete. By increasing the bearing capacity of concrete, palm fiber significantly improves tensile strength. This improvement is mainly due to the uniform distribution of stress in the concrete by the fibers. These fibers create bridges within the concrete that prevent the growth and expansion of cracks under loading.

Date palm fibers in self-compacting concrete reduce fractures caused by tensile stresses. These fibers have the ability to absorb and distribute tensile stresses, which increases the resistance of concrete against bending and tensile loads.

Due to their natural structure and flexibility, date palm fibers help to improve the rheological properties of self-compacting concrete .

Date palm fibers can play an important role in improving the resistance of concrete against thawing and thawing cycles. By reducing the permeability of concrete, these fibers prevent the entry of water and the formation of cracks caused by freezing and melting.

Palm fibers can increase the resistance of concrete against chemical attacks and corrosion. Due to its natural properties and special chemical composition, these fibers prevent the penetration of corrosive substances into the concrete.

Date palm fibers in self-compacting concrete can significantly improve mechanical, rheological and durability properties. By increasing tensile strength, improving rheological properties and reducing cracking, increasing resistance to environmental conditions and positive effects on microscopic and macroscopic levels, these fibers make self-compacting concrete an ideal option for complex and sensitive construction projects.

6 .Conclusion

Self-compacting concrete is one of the most widely used building materials in the world, which is used in construction, but one of the problems of concrete should be kept in mind, its fragility and brittleness, which is considered one of the mechanical behaviors of concrete. to be Measures have been taken to solve it. For this purpose, steel rebars are used to reinforce concrete to limit tension and brittleness. In fact, natural fibers are used to increase the mechanical strength and improve the stability of concrete. In this way, the capacity of palm fibers can be used to limit and control cracks, improve bending and tensile strength, and also improve resistance to stresses. Due to the presence of many palm trees in Behbahan region, easy and cheap access to these fibers, in this research, the effect of these fibers on the hardened properties of self-compacting concrete was investigated in a laboratory manner. The main purpose of this research is to investigate the effect of adding palm tree fibers on the tensile strength of self-compacting concrete. The results of the tests have shown as follows:

1 -The compressive strength of self-compacting concrete cube specimens with palm fibers with different percentages (0.5, 1, 1.5, 2 percent compared to the weight of cement) during 7-day processing, respectively 5.19%,10.87%,17.81% and 22.60% decreased compared to the sample without date fiber.

2 -The compressive strength of self-compacting concrete cube specimens with date fibers with different percentages (0.5, 1, 1.5, 2 percent compared to the weight of cement) during 28 days curing, respectively 4.11%, 9.51%, 15.48% and 22.47% decreased compared to the sample without date fiber.

3 -Tensile strength of cylindrical specimens of self-compacting concrete with palm fibers with different percentages (0.5, 1, 1.5, 2 percent compared to the weight of cement) during 7 days of curing, respectively 16.37%, 34.27%, 56.39% and 82.24% increased compared to the sample without date fiber.

4 -Tensile strength of cylindrical specimens of self-compacting concrete with date fibers with different percentages (0.5, 1, 1.5, 2 percent compared to the weight of cement) during 28 days curing, respectively 13.56%, 27.61%, 46.96% and 67.62% increased compared to the sample without date fibers.

Date palm fibers are not useful at the moment, and when they are piled up, they cause environmental pollution, and due to their inflammability, they increase the possibility of fire in palm groves. The use of natural fibers from the point of view of using waste, reducing environmental pollution, reducing economic costs, its abundance and availability, as well as the ease of using this type of concrete due to the flexibility of the fibers, is significant in curved and resistant structures. And it is a study and it is compatible with the environment and reduces the harmful effects of the environment.

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