Power System Technology
ISSN:1000-3673

Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

Investigating the Characteristics of Engineering Properties of Concrete Made from Hormak River Sediments and Sistan Reed Fibers

Fereshteh Koosha[1], Kazem Shabani Goraji[2*], Jafar Rahnama Rad[3] and Amir Hamzeh Keykha[4]

1PhD Student, Department of Geology, Zahedan Branch, Islamic Azad University, Zahedan, Iran.

2Assistant Professor, Department of Geology, Zahedan Branch, Islamic Azad University, Zahedan, Iran. *Corresponding Author: ka.shabani1354@iau.ac.ir

3Associate Professor, Department of Geology, Zahedan Branch, Islamic Azad University, Zahedan, Iran.

4Assistant Professor, Department of Civil Engineering, Zahedan Branch, Islamic Azad University, Zahedan, Iran.

Abstract

The purpose of this research is to investigate the characteristics of engineering properties of concrete made from Hormak river sediments and Sistan reed fibers.in order to investigate the effect of reed fibers on the engineering properties of concrete, the ratio of water to cement in all designs is constant and equal to 195 to 410 and experiments have been performed on 5 samples containing fibers and without fibers, before determining the optimal amount of each From the mentioned fibers to strengthen the concrete, the results of the necessary tests on fresh and hardened concrete were examined. In this study, in addition to mixing reed fibers with concrete, laboratory methods such as Compressive and tensile strength were used to confirm the accuracy of the results and the importance of selecting suitable materials at low cost in a short time before the concrete mixing project. The results show that the addition of reed fibers to concrete has increased the compressive strength in concrete samples Comparing the results of this test in ordinary concrete and fiber reinforced concrete, showed that this increase in strength at the ages of 7 to 28 days has increased only in samples S2 and S3 and is Similar to the typical concrete example isS1, While in S4 and S5 samples, which were samples of three-row fibers, there is a large decrease in compressive strength. Adding reed fibers initially increases the compressive and tensile strengths, but over time reduces these resistances.

Keywords: Concrete engineering, Sediments, Reed fibers, Harmak River Sistan

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

Introduction

Concrete is the most widely used artificial product in the construction industry. As such, it is the most commonly used material in the world, especially in water sources. Today, almost all streets, highways and other public infrastructure are built with concrete materials (Koosha et al., 2021: 449). Likewise, this process will continue with the increase in the rate of urbanization and industrialization in new civilizations. As the largest component of concrete, large-scale extraction of natural aggregates not only destroys nature, but also consumes a lot of energy and causes air pollution. Therefore, the use of concrete waste with the use of industrial and agricultural solid wastes for the partial replacement of natural stone is considered as one of the effective approaches in protecting the environment and reducing energy consumption. Despite the many negative effects of the widespread use of concrete on the Earth's environment, it currently plays an irreplaceable role in infrastructure and human habitation (Ni et al., 2022: 24).

Concrete aggregates make up approximately three quarters of its volume. Therefore, their quality is of particular importance. Aggregates are not only very effective in the strength of concrete, but the durability and stability of concrete is also largely influenced by the characteristics of these materials. Properties such as shape and size of grains, texture and surface absorption in aggregates affect the properties of concrete prepared from them (Ghasemi et al, 2021: 30). Today, in order to strengthen the structure, new and indigenous methods (fiber concrete) should be used to strengthen the concrete. The main purpose of using fiber concrete is to increase energy absorption and increase hardness; but in addition to the mentioned cases, the tensile and bending strength of concrete also increases. These fibers can also reduce the permeability of concrete and thus reduce water loss on concrete grout. Concrete is a construction material that has been widely used around the world (Koosha et al., 2021: 449). Concrete is very strong in compression but brittle. The brittleness of concrete leads to its low resistance to stress and as a result, the reduction of toughness. Many researchers are trying to increase the hardness of concrete by adding dispersed fibers. Therefore, for a long time, the addition of different fibers has been known as a solution to increase the energy absorption capacity, toughness and increase the resistance of concrete against cracking. Natural fibers have received attention since the past few decades due to their abundant production, easy use, flexibility and cheap availability, and they are used as reinforcement in concrete (Farooqi and Ali, 2018: 1). Today, the use of fiber concrete is expanding due to its advantages. Fibers improve the mechanical properties of concrete under compressive, tensile, bending, shear, dynamic and impact loads, as well as resistance to freezing and wear in concrete. The use of fibers in concrete is one of the methods of improving the flexural and tensile performance of concrete, because of which the brittle mixtures show the behavior of rubber to some extent. Natural fibers are used in the preparation of concrete due to their abundance, easy access and cheapness (Elbehiry et al, 2020: 24).

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

In many researches, the engineering properties of concrete made with different fibers have been investigated, which will be mentioned here: Yoo et al. (2017) conducted a study on comparing the bending behavior of high-performance concrete with composite metal fibers and showed that medium and long fibers improve the bending performance. Also, the use of short and long composite fibers improves toughness and cracking behavior. Zou et al. (2017), in a research, investigated the optimization of performance design based on reliability for seismic strengthening of reinforced concrete structures with fiber reinforced polymer composites. The results showed that the strength of concrete structures is strengthened with fiber. Zhang et al. (2020), in a research, investigated the engineering properties of concrete foam containing seashell waste. The experimental results showed that the efficiency and durability behavior increased or slightly decreased with increasing (foam-filled shell). Although the strength decreases with increasing (shell filled with foam), the rate of strength reduction was lower than the previous foam concrete. Finally, analysis of cross-sectional images of concrete (foam-filled shell) was used to confirm the above results. Zamani et al. (2021), in a research, investigated the characteristics of high resistance fiber self-compacting concrete made from completely recycled aggregate. The results showed that by adding fibers to concrete made with completely recycled fine-grained materials, the mechanical properties are improved and this effect is significantly dependent on the type of fibers, the percentage used and whether the fibers are single or combined. On the other hand, by adding fibers to the basic mixing design, the energy absorption and dissipation capacity of the samples tested in the weight drop test has increased significantly. Makvidi et al. (2021), in a research entitled "Engineering characteristics of sustainable green concrete with environmentally friendly compounds from rubber crumb" reached these conclusions: the use of rubber crumb leads to sustainable use of waste materials, which preserves natural resources. It is destroying and protecting the environment. Liu et al. (2022), in a research, evaluated the concrete engineering properties of recycled biomass aggregates made from coconut shell. The results showed that the mechanical strength of concrete with artificial biomass recycled aggregates achieved at least 90 and 80% of the strength of natural aggregate concrete in 3 days and 28 days, respectively. In addition, compared to natural aggregate concrete, concrete mixed with coconut shell and synthetic biomass recycled aggregate concrete show significant improvements in thermal conductivity, which shows the energy saving potential of the building. Sharma et al. (2022), in a research, comprehensively investigated the effects of mineral additives and fibers on the engineering properties of concrete. The results show that composite concrete and fiber-reinforced concrete with extraordinary performance have seen a visible growth in the last three decades. Also, the results show that today, due to the higher initial cost, the need for special skilled labor for implementation, and different opinions about the different standards of mixed concrete, it is less used. Liu et al. (2022), in a research, studied the engineering properties and environmental

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

effects of sustainable concrete with fly ash. The results showed that mixing fly ash as a part of fine aggregates in concrete can effectively increase the strength of concrete and reduce shrinkage and creep. Therefore, introducing a parameter to record the effect of fly ash content in the prediction model can accurately predict the creep strain of concrete.

In fiber concrete, thousands of short fibers are randomly scattered and distributed in concrete during mixing and improve the properties of concrete in all directions (Vondran et al, 1989: 17). The increase in the use of fiber concrete in building structures is because the reinforcement of concrete with fibers improves toughness, flexural strength, tensile strength, impact resistance, concrete failure mode and useful life of the building (Mazaheripour et al. 2011: 354).

Different fibers such as glass, plastic and steel are used in concrete (Prasad & Mishra, 2019: 522). Synthetic fibers are suitable in terms of resistance and plasticity parameters, but they have limitations due to disadvantages such as production conditions, high cost and environmental effects (Andrew et al, 2019: 6). Therefore, today, researchers have turned to investigating the use of natural fibers, including plant fibers, in concrete (Koosha et al., 2021: 449).

In this research, the engineering properties of concrete made from Hormak river sediments and Sistan reed fibers are measured and evaluated.

Harmak River is located in the northern part of Zahedan city in the southeast of Iran. In terms of stratigraphy, the rock units that outcrop in the studied area are from the Cretaceous to the present era. In order to determine the main sedimentology characteristics of the Harmak River, its sediments are sampled and their granulation is done, and diagrams and textural parameters are prepared to interpret the sediment. The mineralogical composition of particles is also determined as one of the characteristics of sedimentology.

Research methodology

To make self-compacting lightweight concrete, first, different ratios of mixing plan materials were determined for a certain amount of concrete. According to the experience in the laboratory, before mixing the materials in the mixer, water was first added to the mixer and the mixer was allowed to rotate for a few seconds with the water, in addition to reducing the friction of the materials with the mixer body from absorbing the added water. Cement materials should be avoided (Sosa et al, 2020: 3).

In this research, in order to investigate the effect of reed fibers on the engineering properties of concrete, the ratio of water to cement in all designs is constant and equal to 195 to 410, and tests have been performed on 5 samples containing fibers and without fibers, before determining the optimal amount. Each of the mentioned fibers was examined for strengthening concrete, the result of necessary tests on fresh and hardened concrete.

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

Therefore, first, the aggregates, including fine, coarse, and sand, were poured into the mixer with a volume of 150 liters, and after mixing the materials in a dry form for about 20 seconds, the mixing water was added to the mixing materials. After 1 minute, turning off the mixer, cement was added and after turning on the machine, the rest of the water was added. After this time, the fibers were slowly added to the rotating mixer, and finally, after another 2 minutes to distribute the fibers in the mixture, fresh concrete tests and sampling were performed. Tests of fresh self-compacting concrete were performed immediately after this stage of mixing design. After making concrete according to the above model, sampling operation was done to check the mechanical properties and after filling the molds, the samples will be kept at a temperature of +20°C in the laboratory environment for 24 hours and after passing This time and the opening of the molds of the samples will be subjected to wet processing inside the tub with the temperature of the laboratory until the time of testing, which is described below:

Hardened concrete tests

Standard tests of compressive strength and tensile strength were used to investigate the engineering behavior of ordinary concrete and fiber-reinforced concrete.

Compressive strength test

In this study, the compressive strength test based on ASTM C 39-86 standard was used. Compressive strength tests have been performed on cubic samples of 150 x 150 x 150 mm. In compressive strength tests, the cubes were placed in the compression machine in such a way that the two opposite surfaces that were adjacent to the mold during concreting were in contact with the upper and lower stirrups of the machine. The loading speed should be in the range of 0.14 to 0.24 megapascals per second. In this study, the loading speed was considered to be 0.18 MPa/s.

Tensile strength test by halving method

Molded cylindrical samples are used to determine the tensile strength of concrete using the dominization method. This test is performed in accordance with ASTM C 90-496. To perform this test, a standard cylindrical sample with dimensions (height) x 300 (diameter) of 150 mm is placed horizontally along its axis in the compression test machine. A continuous load is applied at a constant speed within the tensile stress range of concrete and between 7 to 14 kg/cm2 (1.4 to 0.7 MPa) until the sample breaks. In this study, the loading speed of the sample was considered to be 1.2 MPa/s. Compressive stress causes uniform tension in the perpendicular direction along the vertical diameter. The tensile strength of halving is obtained from formula (1):

(1) $T=2p/\pi lD$

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

In the above relationship, (T) is the tensile stress (N/mm2), (P) is the breaking load, (L) is the length of the sample, and (D) is the diameter of the sample.
The number of concrete samples tested at the desired ages to investigate the engineering behavior of normal concrete and fiber-containing concretes by performing tests of specific weight, compressive strength and tensile strength using the dominization method are presented in table (1).

Table (1): Number of concrete samples in hardened concrete tests

Test type	Sample dimensions (mm)	number of samples	project title	Test age (days)	processing
pushing resistance	Cubic (15*15)	10	Normal concrete and concrete containing fibers	7, 14 and 28	wet
Tensile strength	Cylindrical	10	Normal concrete and concrete containing fibers	7, 14 and 28	wet

Findings

The sampled points of the Harmak River area

The sampled points were determined to include different parts of the waterways network of the watershed and the main channels of the river (Fig 1).

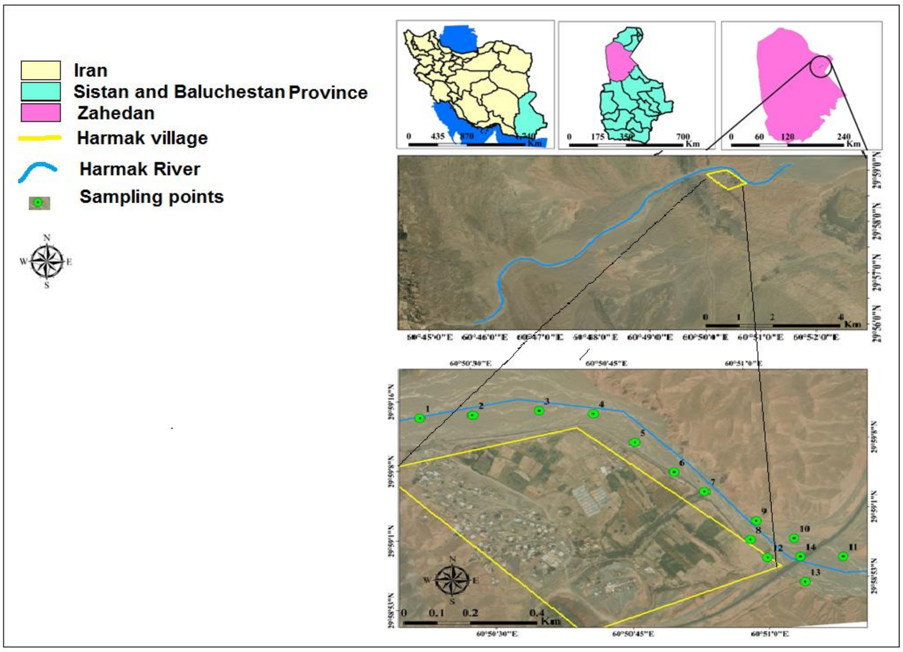

Fig (1): Sampling points at the level of the studied area

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

The investigations carried out on the texture of the sediments of the main branch of the Harmak River show that these sediments are mostly poorly digested with the abundance of particles on the level of gravel. These sediments mainly have a positive skewness. In some parts of this watershed, sediments show negative distortion. The main characteristics of sediments in different parts are summarized in Table (2).

Table (2): Calculated statistical parameters of Harmak River sampling points.

Sample number	Middle(Price)	Average(Price)	Sorting	Tilting
1	-0.8	-1.7	2.3	0.11
2	-2.5	-5.5	2.8	0.31
3	-2.1	-1.96	2.88	0.1
4	-1.8	-1.13	2.93	0.3
5	-2.6	-1.13	3.16	0.33
6	-0.6	-0.23	2.56	0.03
7	-2.1	-0.03	2.84	0.27
8	-2.5	-1.46	3.34	0.46
9	-0.4	-0.23	2.29	0.99
10	-1.1	-0.96	2.46	0.01
11	-2.8	-1.8	3.28	0.4
12	-2.4	-1.66	3.22	0.28
13	-2.4	-2.06	2.25	1.36
14	-2.3	-1.83	3.06	0.2

The results of hardened concrete tests

Investigating the mechanical properties of self-compacting lightweight concrete was determined by performing compressive strength and tensile strength tests on cubic samples with dimensions of 150 x 150 x 150 mm and cylindrical samples with dimensions (height) x 200 (diameter) of 150 mm.

Compressive strength test results

In this study, the compressive strength test based on ASTM C 39-86 standard was used. Compressive strength tests have been performed on 150 x 150 x 150 mm cube samples. In the compressive strength tests, the cubes were placed in the pressure machine in such a way that the two opposite surfaces that were adjacent to the mold during concreting were in contact with the upper and lower jaws of the machine. The compressive strength test was performed after storage in humid conditions at the age of 7 to 28 days. The loading speed should be in the range of 0.14 to 0.24 megapascals per second. In this study, the loading speed was considered to be

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

0.18 MPa/s. The results of compressive strength, the compressive strength of normal concrete samples (Control), lightweight self-compacting concrete reinforced with reed fibers are shown in Table (2) and Fig (2).

Table (2): Results of compressive strength of concrete in five concrete samples reinforced by reed fibers

Sample number	Compressive strength (Mpa)		
	Sample age	Sample age	Sample age
S1	169/85	225/33	348/19
S2	189/66	294/97	395/51
S3	228/16	308/56	385/56
S4	159/66	221/37	341/4
S5	143/24	201/55	307/43

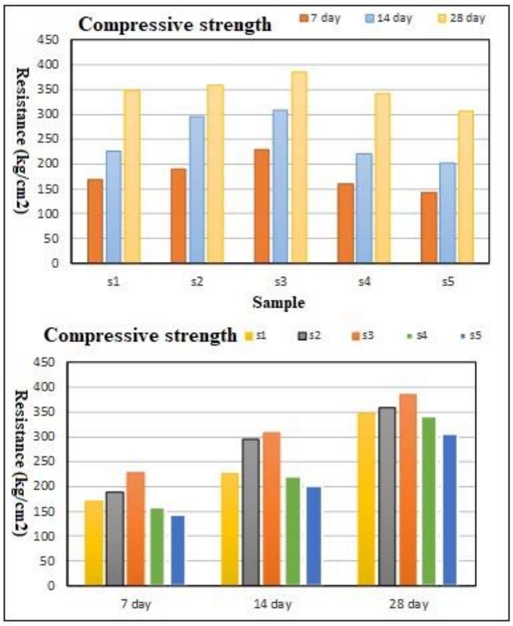

Fig (2): Compressive strength of five samples reinforced by reed fibers at different ages

The results show that the presence of reed fibers, due to the strong bond between fibers and concrete components, and from another point of view, fibers in concrete can play the role of stirrup. Stirrups around the column prevent cracks and increase stress by preventing the increase of diagonal strain, and increase the compressive strength by inhibiting lateral bending (Gholampour et al, 2019). Fibers somehow play the same role in concrete. Only fiber, unlike Stirrup, which strengthens concrete from the outside, increases the compressive strength from the inside by creating continuity and friction. After paying attention to this point, it is necessary to carefully choose the type of fibers to increase the friction (Peyre et al, 2019). But the addition

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

of fibers will reduce the compressive strength. This decrease in compressive strength may be because polypropylene fibers in self-compacting lightweight concrete reduce the compressibility of concrete, which may cause weak points in the concrete texture (due to local porosity from air bubble penetration). And as a result, it provided pressure reduction (Liu et al, 2019). According to the mentioned point, because of the smooth surface (low friction) reed fibers cause an insignificant increase in compressive strength and the presence of a low modulus of elasticity compared to concrete causes a decrease in compressive strength, which in general reduces the dominant drop.
In both types of fiber concrete samples, during compressive loading, the nature has changed from sudden brittle failure to soft and gradual failure (Pham et al, 2019). The reason for this can be found in several reasons. Due to the low plasticity of the matrix of cement and aggregate, it can bear the load until it breaks due to the low plasticity during operation, and after the sudden break, the fibers are responsible for keeping the piece. The concrete blocks together change the failure from sudden to brittle (Fig 3).

Fig (3): Fracture transformation from brittle to soft

The results of the tensile strength test using the cylinder halving method
This test method is used to determine the tensile strength of concrete by splitting the molded cylindrical samples in half (Fig 4). This test is performed according to ASTM C 496-90 standard. To perform this test, we place a standard cylindrical sample with dimensions (height) of 200 (diameter) of 150 mm horizontally along its axis in the compressive strength testing machine. A continuous load is applied at a constant speed within the tensile stress range of concrete between 7 and 14 kg/cm2 (MPA 1.4 to 0.7) until the sample breaks. Compressive stress causes uniform tension in the perpendicular direction along the vertical diameter. The tensile strength of double-teaming is obtained from equation (2) (Qian and Stroeven, 2000):
(2) $T=2P/\pi lD$
The parameters used in this regard are: (T) tensile stress (N/mm2), (P) breaking load, (L) sample length and (d) sample diameter. Tensile strength test was performed to determine the

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

tensile strength of concrete by the dominization method on cylindrical samples. The samples were tested at the ages of 7 to 28 days and in humid conditions.
Tensile strength for all five mixes, in the specified storage conditions at the ages of 7 to 28 days, are shown in Table (3) and their comparison is shown in Fig (4).

Table (3): Tensile strength results in all five studied samples

Sample number	Tensile strength (Mpa)		
	Sample age	Sample age	Sample age
S1	17/58	23/039	36/30
S2	19/17	31/95	37/13
S3	22/56	31/38	39/30
S4	15/82	19/70	30/31
S5	14/21	19/91	29/99

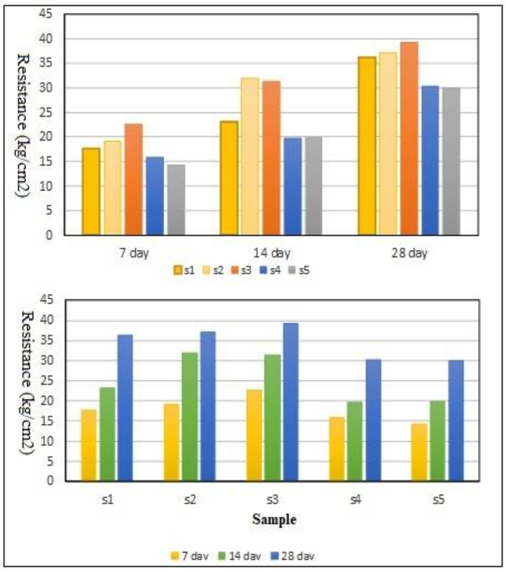

Fig (4): Tensile strength results in all five studied samples

The results show that the presence of fibers increases the tensile strength, so that this increase is more noticeable in the S3 sample, which can be due to the higher tensile strength of fibers compared to other fibers (Wang et al, 2019). One of the main weaknesses of concrete compared to reed fibers as a building material is low tensile stress, therefore, during the implementation of concrete, from the very beginning with the creation of surface cracks due to shrinkage until the time of use due to tensile stress caused by loading. We face small and large cracks (Shon et al, 2019). The fibers are prevented from spreading by creating a communication bridge in the cracks. The mechanism of increasing tensile strength by fibers also follows this law, when concrete is subjected to tensile stress, after reaching the ultimate tensile strength of concrete

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

and creating cracks in each area, the responsibility of transferring the load in that area is the responsibility of the fibers in that area. (Krahl et al., 2020). This indicates the necessity of uniform distribution of fibers and the fibers act like a bridge. Now, to what extent it increases the resistance, by examining the fibers used in the design, we found that it depends on several reasons, such as: the shape of the fibers, the amount of adhesion to the concrete, the length of the fibers, etc.

The failure mode of fiber concrete samples containing fibers under tensile test is different from normal concrete samples and has changed from brittle (sudden) failure to soft and gradual failure. What happens when the tensile strength increases as a result of the use of fibers can be explained in such a way that when the fibers are split between the split parts of the matrix, through the transfer of stresses from the matrix to the fibers, the strain They bear greater tensile strength, as a result, an increase in tensile strength is observed (Singh et al, 2020).

Fig (5): Brazilian tensile strength in cylindrical samples

The results of the modulus of elasticity test

If the two components of concrete, i.e. hydrated cement paste and aggregates, are affected by stress separately, they will show a relatively linear relationship between stress and relative deformation (Zhang et al, 2019). Of course, theories about the non-linearity of the relationship between stress and relative deformation of hydrated cement paste have been presented (Rahimi-Aghdam et al, 2019, Tao et al, 2019, Páez-Flor et al, 2019). The reason for the curvature of the stress-strain relationship for the composite material (concrete) is the presence of the interface between the cement paste and its aggregates and the development of adhesion microcracks on these surfaces. One consequence of the development of cracks will be the reduction of the effective surface that resists the incoming load. So that the local stress is higher than the nominal stress which is calculated based on the total cross-sectional area of the sample (Moody et al, 2020).

Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

The results of the modulus of elasticity test

If the two components of concrete, i.e. hydrated cement paste and aggregates, are affected by stress separately, they will show a relatively linear relationship between stress and relative deformation (Zhang et al, 2019). Of course, theories have been presented about the non-linearity of the relationship between stress and relative deformation of hydrated cement paste (Rahimi-Aghdam et al, 2019, Tao et al, 2019, Páez-Flor et al, 2019). The reason for the curvature of the stress-strain relationship for the composite material (concrete) is the presence of the interface between the cement paste and its aggregates and the development of adhesion microcracks on these surfaces. One consequence of the development of cracks will be the reduction of the effective surface that resists the incoming load. So that the local stress is higher than the nominal stress which is calculated based on the total cross-sectional area of the sample (Moody et al, 2020).

When the applied stress increases to more than 70% of the ultimate strength, cracking develops in the mortar and the curvature of the relative stress-strain curve increases with increasing trend. This is the peak point of the relative stress-strain curve.

The modulus of elasticity is determined in two ways:

- Static elasticity modulus
- Dynamic elastic modulus

The slope of the relationship between stress and strain determines the elastic modulus. The dynamic modulus of elasticity is obtained from the vibration of concrete samples, and due to the absence of significant applied stress, no microcracks will be created in the concrete and there will be no creep. Therefore, the dynamic modulus of elasticity will be higher than the static modulus of elasticity (Neville, 1995).

To determine the modulus of elasticity in the measurement of compressive strength, by installing a strain gauge on the system, we made it possible to determine the strain of the sample due to different forces. Determining the modulus of elasticity includes measuring the strain for different loads and drawing the stress-strain curve. According to the standard, the modulus of elasticity is calculated from the strain corresponding to 45% of the ultimate strength according to formula (3) (Euro light concrete, 1998).

(3) $E=\sigma 45\%\sigma v/\varepsilon$

In this equation, (E) is the modulus of elasticity in megapascals (newtons per square millimeter), ($\sigma 45\%\sigma v$) the stress corresponding to 45% of the ultimate strength in megapascals and (ε) the strain corresponding to 45% of the ultimate strength.

The elastic modulus increases with the increase of compressive strength of concrete. The modulus of elasticity of concrete depends on the type of aggregate, mixing ratios, processing conditions, loading rate and measurement method, and the range of changes of the measured values is usually determined between 80% and 120%. According to ACI318-05 regulations, the modulus of elasticity of concrete (Ec) for concretes with volume zone Wc varying between

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

1500 and 2500 kg/m3 is calculated from equation (4) in terms of megapascals. Ec as the slope of the line drawn from zero stress to the point like compressive stress fc is 0.45 (Euro light concrete, 1998).

(4) $E_c=0.043\ W_c^{1.5}\ \sqrt{f_c}$

In this regard, Wc is the specific weight of concrete, which is between 1440 and 2400 kg/m3, where fc is the compressive strength of a standard cylindrical sample with a diameter of 150 and a height of 300 mm, in MPa, and Ec is the static modulus of elasticity. It is in gigapascals. According to ASTM C576 regulations, the density used in the above formula is the equilibrium density of concrete, and it stipulates that the equilibrium density of concrete can be considered 50 kg/m3 less than the density of fresh concrete. The proposed relationship is for the low resistance range, and the ACI213 regulation suggests another relationship for the high resistance range, which is:

(5) $E_c= C W_c^{1.5}\sqrt{f_c}$

Where C=0.038 for resistances up to 35 MPa and C=0.04 for resistances higher than 35 MPa.

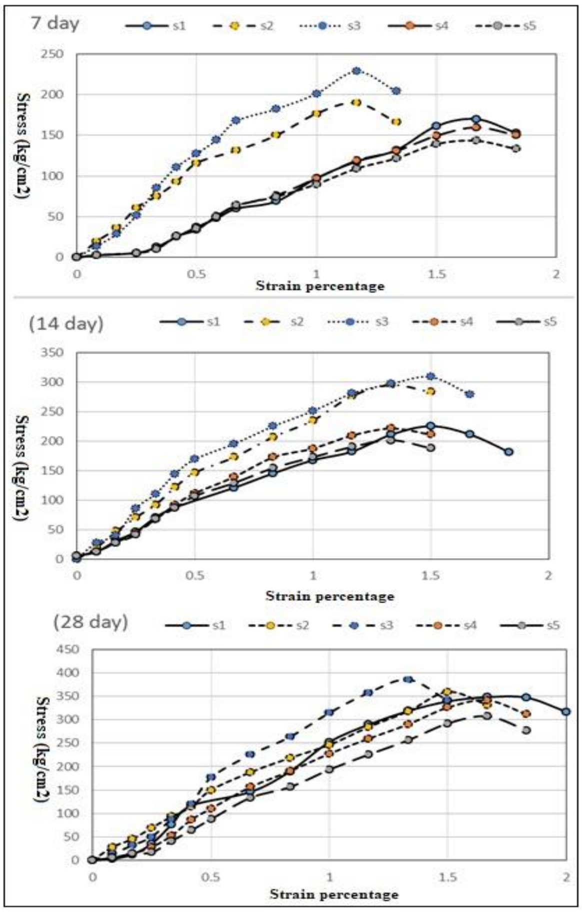

Fig (6): The results of the elasticity modulus test

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

Conclusion

In this research, in order to investigate the effect of the use of reed fibers on the engineering characteristics of concrete, after determining the optimal amount of fibers to strengthen concrete, necessary tests were performed on fresh and hardened concrete. According to the conducted tests, the following results have been obtained:

- The construction of concrete reinforced by reed fibers shows that by adding fibers, the flowability and filling properties of concrete are reduced.
- Adding reed fibers to concrete has increased the compressive strength of concrete samples. By comparing the results of this test in normal concrete and fiber-reinforced concrete, it showed that this increase in strength at the ages of 7 to 28 days only increased in S2 and S3 samples and is similar to normal concrete sample S1, while In samples S4 and S5, which were samples of three-row fibers, a great decrease in compressive strength can be seen.
- In the results of the tensile strength, the same as the results of the compression test can be seen, so that an increase in the tensile strength can be seen in all the samples, while in the comparison charts between the samples of normal concrete and concretes reinforced by fibers In samples S4 and S5, where three rows of fibers were used in their construction, a decrease in tensile strength can be seen.
- Finally, it can be said that the addition of reed fibers initially increases the compressive and tensile resistances, but after a period of time, these resistances decrease.
- The only advantage of using reed in concreting, based on the study of Taghizadeh Qahi (2013), can be considered to be the provision of very good adhesion between concrete, mold and joinery coating. It is also a good insulator against heat and sound transmission.
- The results of this research are similar to the results of Wang and Han (2018), which stated that reed fibers can effectively improve construction efficiency, but cannot increase resistance.
- Adding fibers in the industry, considering the multitude of concrete structures and their many weaknesses, it is necessary and important to create and use solutions to fix and improve these defects.

Based on the present study, it is suggested:

- At first, these defects should be addressed in the use of reed fibers in concrete.
- The effect of adding fibers as a combination on the mechanical properties of self-compacting concrete (such as the combination of reed fibers with other fibers) should be studied.
- Investigate the behavior of this concrete in destructive environments such as acidic, salty and sulfated environments.
- Investigate the effect of concrete containing reed fibers in the environment with increasing and decreasing temperature.

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

References

1. Andrew, J. J., Srinivasan, S. M., Arockiarajan, A., & Dhakal, H. N. (2019). Parameters influencing the impact response of fiber-reinforced polymer matrix composite materials: A critical review, Composite Structures, 224, 111007.
2. Elbehiry, A. Elnawawy, O.Kassem, M. Zaher, A. Uddin, N. Mostafa, M. (2020), Performance of concrete beams reinforced using banana fiber bars, Case Studies in Construction Materials, V13.
3. Euro light concrete (1998) Definitions and international consensus Report, European Union BE 96-3942/R1
4. Farooqi, MU, Ali, M., (2018), Contribution of plant fibers in improving the behavior and capacity of reinforced concrete for structural applications. Construction and Building Materials. V182, PP 94-107
5. Ghasemi, S., Nikudel, M., Raeis Ghasemi, A. M., & Yousefvand, F. (2021). Effect of type and texture of aggregates on strength properties of sulfur concrete and portland concrete. Scientific Quarterly Journal of Iranian Association of Engineering Geology, 14(1), 29-42.
6. Gholampour, A., Fallah Pour, A., Hassanli, R., & Ozbakkaloglu, T. (2019). Behavior of actively confined rubberized concrete under cyclic axial compression. Journal of Structural Engineering, 145(11), 04019131.
7. Koosha, F., Shabani Gorji, K., Rahnama Rad, J., & Kikha, A. H. (2021). Investigating the effect of reed fibers on concrete engineering characteristics made of sediments of Hormak River (North of Zahedan) and its use in Reinforcement of structures against earthquakes. Geography (Regional Planning), 11(45), 447-461.
8. Krahl, P. A., Pereira, M. F., Dalfré, G. M., & Siqueira, G. H. (2020). A novel approach to characterize the direct shear pullout behavior of single hooked steel fibers. Cement and Concrete Composites, 103685.
9. Liu, H, Li, Q, Ni, S, (2022), Assessment of the engineering properties of biomass recycled aggregate concrete developed from coconut shells, Construction and Building Materials, Volume 342, Part A, 1 August 2022, 128015
10. Liu, X., Wu, T., Yang, X., & Wei, H. (2019). Properties of self-compacting lightweight concrete reinforced with steel and polypropylene fibers. Construction and Building Materials, 226, PP 388-398.
11. Liu, Z, Takasu, K, Koyamada, H, Suyama, H, (2022), A study on engineering properties and environmental impact of sustainable concrete with fly ash or GGBS, Construction and Building Materials, Volume 316, 17 January 2022, 125776.
12. M.A.Qaidi, Sh, Zayia Dinkha, Y, H.Haido, J, Hasan Ali, M, A.Tayeh, B, (2021), engineering properties of sustainable green concrete incorporating eco-friendly aggregate of crumb rubber: A review, Journal of Cleaner Production, Volume 324, 15 November 2021, 129251.

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

13. Mazaheripour, H., Ghanbarpour, S., Mirmoradi, S. H., and Hosseinpour, I. (2011), The effect of polypropylene fibers on the properties of fresh and hardened lightweight self-compacting concrete. Construction and Building Materials, 25.1, pp 351-358.
14. Moody, L. C., Powell, I. J., Lewis, D. O., Johnson, M. C., Butler, B. G., & Paramore, J. D. (2020). Cross-sectional area measurement by optical and electrical resistance methods for subscale mechanical testing of near-net-shape titanium components. International Journal of Refractory Metals and Hard Materials, 105265.
15. Neville, A. M. (1995). Properties of concrete (Vol. 4). London: Longman.
16. Ni, S, Liu, H, Li, Q, Quan, H, Gheibi, M, Fathollahi-Fard, A, Tian, G, (2022), Assessment of the engineering properties, carbon dioxide emission and economic of biomass recycled aggregate concrete: A novel approach for building green concretes, Journal of cleaner production, Volume 365, 10 September 2022, 132780.
17. Páez-Flor, N. M., Rubio-Hernández, F. J., & Velázquez-Navarro, J. F. (2019). Microstructure-at-rest evolution and steady viscous flow behavior of fresh natural pozzolanic cement pastes. Construction and Building Materials, 194, PP 360-371.
18. Peyre, K., Tourlonias, M., Bueno, M. A., Spano, F., & Rossi, R. M. (2019). Tactile perception of textile surfaces from an artificial finger instrumented by a polymeric optical fibre. Tribology International, 130, PP 155-169.
19. Pham, P. N., Zhuge, Y., Turatsinze, A., Toumi, A., & Siddique, R. (2019). Application of rubberized cement-based composites in pavements: Suitability and considerations. Construction and Building Materials, 223, PP 1182-1195.
20. Prasad, P. K., & Mishra, R. S. (2019). Study in Stress Behaviour of Fibre (Steel & Glass) Reinforced Concrete, nternational Research Journal of Engineering and Technology (IRJET), 6 (6), PP 520-527.
21. Qian, C.X., Stroeven P. (2000) .Development of hybrid polypropylene and steel fiber reinforced concrete. Cem. Concr. Res. 30, PP 63–69.
22. Rahimi-Aghdam, S., Masoero, E., Rasoolinejad, M., & Bažant, Z. P. (2019). Century-long expansion of hydrating cement counteracting concrete shrinkage due to humidity drop from self-desiccation or external drying. Materials and Structures, 52(1), 11.
23. Sharma, R, GookJang, J, Pal Bansal, P, (2022), A comprehensive review on effects of mineral admixtures and fibers on engineering properties of ultra-high-performance concrete, Journal of Building Engineering, Volume 45, January 2022, 103314.

Power System Technology
ISSN:1000-3673
Received: 06-06-2024 Revised: 15-07-2024 Accepted: 28-08-2024

24. Shon, C. S., Mukashev, T., Lee, D., Zhang, D., & Kim, J. R. (2019). Can common reed fiber become an effective construction material? Physical, mechanical, and thermal properties of mortar mixture containing common reed fiber. Sustainability, 11(3), 903.
25. Singh, D. K., Vaidya, A., Thomas, V., Theodore, M., Kore, S., & Vaidya, U. (2020). Finite Element Modeling of the Fiber-Matrix Interface in Polymer Composites. Journal of Composites Science, 4(2), 1-13.
26. Sosa, I., Thomas, C., Polanco, J. A., Setién, J., & Tamayo, P. (2020). High Performance Self-Compacting Concrete with Electric Arc Furnace Slag Aggregate and Cupola Slag Powder. Applied Sciences, 10(3), PP 1-17
27. Tao, J., Wei, X., & Luo, Y. (2019). Comparison of non-contact autogenous shrinkage measurements and the stress ratio of capillary stress to compressive strength. Construction and Building Materials, 206, PP 226-235.
28. Vondran, G.L. Nagabhushanam, M. Ramakrishnan, V, (1989), Fatigue Strength of Polypropylene Fiber Reinforced Concretes, pp 533-543 in Fiber Reinforced Cements and Concretes, Recent Developments, Edited by Swamy, R.N., Barr, B., September1989.
29. Wang, D., Ju, Y., Shen, H., & Xu, L. (2019). Mechanical properties of high performance concrete reinforced with basalt fiber and polypropylene fiber. Construction and Building Materials, 197, PP 464-473.
30. Yoo, D. Y., Kim, S. W. and Park, J. J. (2017). Comparative flexural behavior of ultra-high-performance concrete reinforced with hybrid straight steel fibers. Constr. Build. Mater. 132: 219-229.
31. Zamani, A. A., Ahmadi, M., & Dalvand, A. (2021). Material Properties of High-Strength Self-Compacting Concrete Made with Fully Recycled Aggregate: An Experimental Study. Civil Infrastructure Researches, 7(1), 1-16.
32. Zhang, D., Mao, M., Zhang, S., & Yang, Q. (2019). Influence of stress damage and high temperature on the freeze–thaw resistance of concrete with fly ash as fine aggregate. Construction and Building Materials, 229, 116845.
33. Zhang, Y, Da Chen, D, Liang, Y, Qu, K, Lu, K, Chen, Sh, Kong, M, (2020), Study on engineering properties of foam concrete containing waste seashell, Construction and Building Materials, Volume 260, 10 November 2020, 119896.
34. Zou, X, Wang, Q, Wu, J, (2017), Reliability-based performance design optimization for seismic retrofit of reinforced concrete buildings with fiber-reinforced polymer composites, Advances in Structural Engineering, PP 1-14.