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Effects of Kortta fibres and microsilica on the mechanical properties of lightweight concrete in oil product environments

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Abstract:
Crude oil and its products are strategic and vital goods for most countries in the world. It is necessary to store these products in the production and transfer chain and send them to refineries, ports, and airports for military and national purposes. Lightweight concrete is propounded as a useful replacement for normal concrete due to its low specific weight and acceptable resistance property; however, compared to normal concrete, it is considered to be more permeable, less durable, and less resistant. Therefore, in this study, the reliability of this synthetic material in oil conditions has been investigated. In this regard, two groups of samples were investigated under normal and oil environmental conditions, polymer Kortta fibres with percentages of 0; 0,5; 1,0; 1,5; and 2,0 % and microsilica with percentages of 0 and 15 % by cement weight were incorporated alone and combined. Subsequently, tests were performed on the specimens after 90 days. The results showed that the combination of microsilica and Kortta fibres causes a significant increase in lightweight concrete strength and impermeability.

Keywords:
oil; Kortta fibre; microsilica; polymer; structural lightweight aggregate concrete

1 Introduction

Competition in civil engineering markets usually imposes low-cost, low-density, and environmentally resistant materials with minimal maintenance and extended service life to withstand the undesired severe loading and aggressive environmental conditions. Consequently, the use of advanced composite materials as reinforcements for different structures and new materials has been developed in the past decades through new construction and rehabilitation applications. Structural lightweight concrete also has a special place in the construction industry because of its lightweight and acceptably resistant structure. The properties of lightweight concrete are primarily dependent on the type of synthetic lightweight aggregates that play an important role in improving the internal process of concrete and researchers have been able to introduce new types of green lightweight concrete with high strength by changing the mixing plan [1-5]. Therefore, this concrete with low density and high elasticity can be used in most structures, including buildings and for repairing concrete decks [6]. However, the porosity in this type of concrete and its low tensile strength have prevented the use of this type of concrete between employers and its expansion. Various methods have been proposed to improve the permeability and water absorption of light grains from cement paste and ultimately reduce the strength of the cement paste matrix [7-12].

Using fibre-reinforced polymers (FRPs) as composite materials is a powerful strengthening technique for various structural applications and has attracted the attention of many researchers in recent years owing to the above-mentioned characteristics. The FRP technique has been successfully implemented to strengthen bridges, buildings, tunnels, silos, reservoirs, and underground infrastructures. FRPs are used as high-performance materials owing to advantages such as lightweight, fatigue resistance, high tensile strength, anti-corrosion, and thermal insulation [1]. In regards to the effect of polyvinyl alcohol fibre (PVA) on the flexural strength of concrete, it has been observed that the fibres have a significant effect on increasing the strength of high-strength cement composites [13]. In a previous study, it was noted that owing to the incompatibility between the types of fibres, the creation of capillary space by the fibres was not effective in increasing the impermeability of concrete [14]. The presence of polymers also improves the permeability of lightweight concrete, the degree of which is highly dependent on the presence of the polymer. Latex polymers increase stability by creating a hydrophobic effect or covering the pores [15]. In addition, pozzolanic additives, such as microsilica and nanosilica, act as micro fillers and cement adhesive additives, increase cement density, and reduce pores and permeability [16-19]. Regarding the effects of nanosilica and microsilica alone and in combination, researchers have shown that the combination of these two additives to the optimal amount in concrete samples increases the compressive strength of the samples in the short and long term.

The increase in compressive strength in this case leads to a further decrease in permeability compared to other samples [20]. With the presence of 5; 10; 15; 20; and 30 % microclay compared to the volume of cement used in concrete, the optimal percentage of this additive is determined as 15 % [21]. Mineral oils reduce the bearing capacity of industrial structures in the direction of the desired goals [22]. When examining the changes in compressive strength and absorption characteristics of concrete samples cured in seawater and 100% humidity for 365 days and then exposed to crude oil, the final resistance of samples containing ash is found to be higher than those cured for lesser time and slightly lower than the resistance of samples without ash. After 90 days, owing to the stability of crude oil absorption, the resistance decreases to a constant level [23]. In a previous study, to investigate the negative effects of crude oil on the compressive strength of low and high-strength concretes, samples cured in crude oil were compared with samples cured in laboratory air for 280 and 28 days. The resistance of the samples cured in oil for 280 days is slightly higher than that of the samples cured for 28 days, which is due to the increasing trend of resistance over time; this increase in the samples placed in the laboratory environment is greater because they are not placed in a corrosive environment [24]. In addition, petroleum products can reduce the compressive strength of concrete in the long term, and this reduction is greater in concrete samples exposed to gas oil than in samples exposed to petrol. By using microsilica and nanosilicone, the strength of concrete can be increased by reducing the destructive effects of petroleum products [25]. In general, oil and its derivatives have destructive effects on cement and concrete [26-28]. The negative effects of engine oil on concrete with silica fume are significantly less [29]. Consequently, there is increasing focus on improving and increasing the durability of all types of concrete in developing countries. There is particular demand for concrete used in structures such as oil tanks, which, in addition to having strategic security against explosive loads, must have an optimal relationship between specific weight and resistance and maintain ideal permeability against harmful atmospheric and environmental factors. Reducing the durability of concrete in corrosive conditions while increasing the cost of repair and reconstruction leads to environmental damage. The damage to concrete structures, which is mainly caused by the lack of understanding of the behaviour of concrete in operating conditions, causes significant damage to the construction industry and operators. Therefore, in the present study, an attempt has been made to investigate the effect of an oil substance on lightweight concrete. The petroleum product in question is gasoline, and because of the presence of sulphur in this product, it is necessary to investigate the effect of this product on the properties of lightweight concrete.

The proposed plan of this project is to modify and improve the properties of lightweight concrete with microsilica and polymer Kortta fibres. Therefore, in this regard, the parameters including compressive, tensile, and bending strengths and the relationship between them and percentages of additives are investigated. Further, the water and gasoline absorption of modified lightweight concrete in laboratory and oil conditions are determined, as well as the optimal mixing percentage for fibre additives is obtained with the aim to improve the mechanical properties and durability of lightweight concrete.

2 Methodology

2.1 Light aggregates

In this study, to develop concrete specimens, the extracted clay of Leca Company with the Leca500 trade name with 2 to 10 mm grain grading prepared at the Leca Saveh factory has been used. The specific weights of non-compacted Leca and Leca grain are 568 and 645 kg/m^3, respectively. According to ASTM C 127, water absorption after 0,5; 1,0; and 24 h is 5,5; 5,8; and 9,4%, respectively. Figure 1 shows the Leca and sand grading curves.

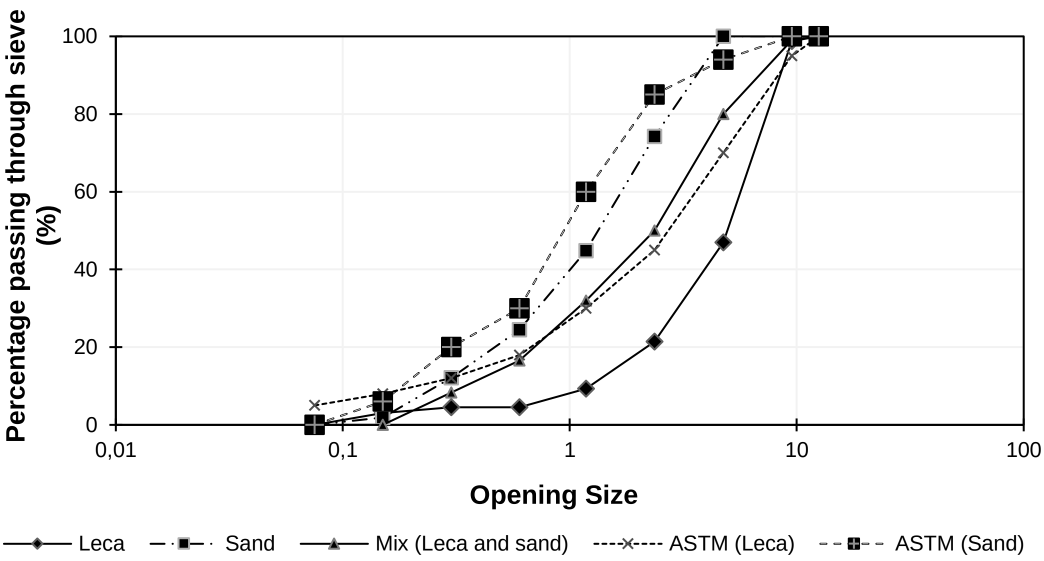

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Figure 1. Leca and sand grading curves

2.2 Sand, cement, and plasticiser

Double-washed sand with 2530 kg/m^3 specific weight, Portland cement type 2 from Abik factory with ASTM C150 standard and 3100 kg/m^3 specific weight, and silkcrete pr2 superplasticiser based on polycarboxylic-ether were used.

2.3 Microsilica, Kortta fibre, and gasoline

Consumable microsilica is produced by the Iran Ferrosilice company, and Kortta fibres are made of nano-modified polyolefin and polypropylene, which is a product of the Sirjan nano yarn and granule company. Specifications of the gas oil used in this project were provided by the National Petroleum Products Distribution Company. The following tables (Table 1 and 2) present Kortta fibre and microsilicia properties.

Table 1. Kortta fibre properties

Ingredients	Polypropylene-modified copolymer
Appearance colour	Black-white-grey
Length	19-39-54 mm
Tensile strength	570–900 Mpa
Specific weight	0,9–4,5 kg/m^3

Table 2. Microsilica chemical composition

Constituent oxides	**Microsilica** (%)	**Portland cement** (%)
Sio_2	91,10	21,0
Al_2o_3	1,55	4,6
Fe_2o_3	2,00	3,2
CaO	2,42	64,5
MgO	0,06	2,0
SO_3	0,45	2,9
Na_2O+K_2O	-	1,0

2.4 Mixing design and used materials

Table 3 lists ten mixing designs of the structural light aggregate concrete. The mixing design method is as follows: First, Leca and half of the required sand and cement are added to the mixer. After dry mixing, the remaining sand and half the water are added to the mixture. The mixing design procedure is continued, and then the rest of the water with the microsilica and super plasticiser are added to the mixture, and the operation is continued. Subsequently, the device is slowed down, and if necessary, additional water is gradually added to the mixture according to the mixing ratios (over 2 to 4 min). All the ingredients are mixed for 1 min. Finally, the Kortta fibres are added to the mixture, and the mixing operation is continued for another 3 min. In order to prevent the cement from balling, the light grain and sand are kept dry, and half of the sand is added after the cement to prevent direct contact of water with the cement. Preparation and curing method

In order to cure the concrete samples after construction, they were placed in a mold and nylon cover for 24 h to keep them moisturized and then placed in a pool of water at a temperature of 19-23 °C.

A total of 240 samples were prepared using the 10 mixing designs and removed from the pool after 28 days of curing in water; 120 samples were dried in laboratory for 5 days and then placed in gasoline for 90 days. Another 120 samples were placed in the laboratory for 90 days. Finally, hardened concrete tests were performed on all 240 samples.

For this study, concrete without additives is called the LW or control sample. Concrete with 15 % microsilica additive and 0 % Kortta fibre is called LWm, and if this concrete contains Kortta fiber at percentages of 0,5; 1,0; 1,5; and 2,0 %, it is called LWmc0,5; LWmc1; LWmc1,5; and

LWmc2, respectively. Samples contain Kortta fiber with percentages of 0,5; 1,0; 1,5; and 2,0 % are denoted as LWc0,5, LWc1, LWc1,5 and LWc2, respectively. A total of 60 cubic samples (15×15×15 cm) for the compressive strength test according to the ASTMC39 standard, 60 cylindrical samples (15×30 cm) for the tensile test according to the ASTMC496 standard, 60 samples (10×10×50 cm) for the flexural test according to the ASTMC78 standard, and 60 cubic samples (15×15×15 cm) for the short-term water absorption test according to the BS1881-122 standard were prepared for each experiment and from each mix design; an average of three samples was considered as the final resistance. The experiments were performed at 90 days.

Table 3. Lightweight concrete mixing design

Specimens	W/C	Sand	Cement	Super plasticiser	Leca	Micro-silica	Fibre	Slump
	(%)	(kg/m^3)	(kg/m^3)	(%)	(kg/m^3)	(%)	(%)	(cm)
LW	0,4	890	410,0	2,0	300	-	-	7
LWc0,5	0,4	890	410,0	2,0	300	-	0,5	7
LWc1,0	0,4	890	410,0	2,0	300	-	1,0	6
LWc1,5	0,4	890	410,0	2,0	300	-	1,5	5
LWc2,0	0,4	890	410,0	2,5	300	-	2,0	5
LWm	0,4	890	348,5	3,1	300	15	-	7
LWmc0,5	0,4	890	348,5	3,3	300	15	0,5	7
LWmc1,0	0,4	890	348,5	3,3	300	15	1,0	6
LWmc1,5	0,4	890	348,5	3,3	300	15	1,5	5
LWmc2,0	0,4	890	348,5	4,0	300	15	2,0	5

3 Results and discussions

3.1 Compressive strength

According to Figure 2, compressive strength of all concrete specimens modified by fibre and microsilica additives increases significantly compared to that of the non-modified specimens.

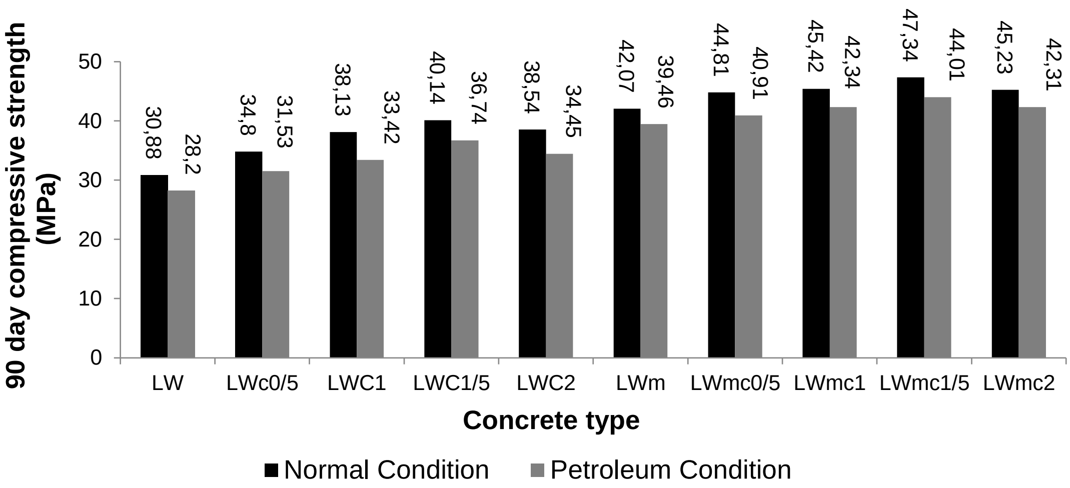

Figure 2. Comparison between the 90-day compressive strength of specimens in normal and petroleum conditions

As shown in Figure 2, compared to that of the control sample, the compressive strength of samples containing Kortta fibre without microsilica in both environmental conditions increase significantly in terms of an increase in the resistance. Compared to that of the control sample, in the sample with 0,5 % Kortta, an increase of 12,69 % under normal conditions and 11,80 % under aggressive conditions was observed, and the highest percentage of increase in compressive strength is observed in the samples with 1,5 % fibre. The presence of fibre in proportion to the adhesive strength of cement can increase the strength of the internal elements of concrete against internal forces and separation. This strength increase is also evident in concrete containing microsilica and without the presence of fibre. The highest compressive strength increase among the ten mixing designs under normal and aggressive conditions is observed in the LWmc1,5 mixing design. This can be attributed to the increase in the adhesive strength of the cement matrix and Kortta fibre, which leads to the maximum efficiency of the tensile strength of the fibre against internal stresses and maintains the integrity of the concrete.

3.2 Tensile strength

As shown in Figure 3, with the presence of Kortta fibre in concrete without microsilica in normal conditions, a significant increase in tensile strength is obtained, and this increase is greater than the increase in compressive strength that can be attributed to the presence of the fibres. Similar to that in the normal condition, with an increasing in the percentage of fibre, the tensile strength of the samples in the group of mixing designs in the gasoline curing condition increases; with the presence of Kortta fibre in concrete without microsilica, a significant increase in tensile strength is achieved. From the graph, it can be observed that with microsilica the tensile strength in both environmental conditions increase. In aggressive conditions, the tensile strength of LWm increases by approximately 62,5 % compared to that of LW. The highest tensile strength in normal conditions is achieved in the sample containing 1,5 % fibre and 15 % microsilica, with a 97 % increase compared to that of LW. Therefore, the modification of the tensile strength of concrete is more significant compared to that of the compressive strength. The resistance of the fibre against sample failure and tearing of the fibre at the location of concrete fracture attest to this.

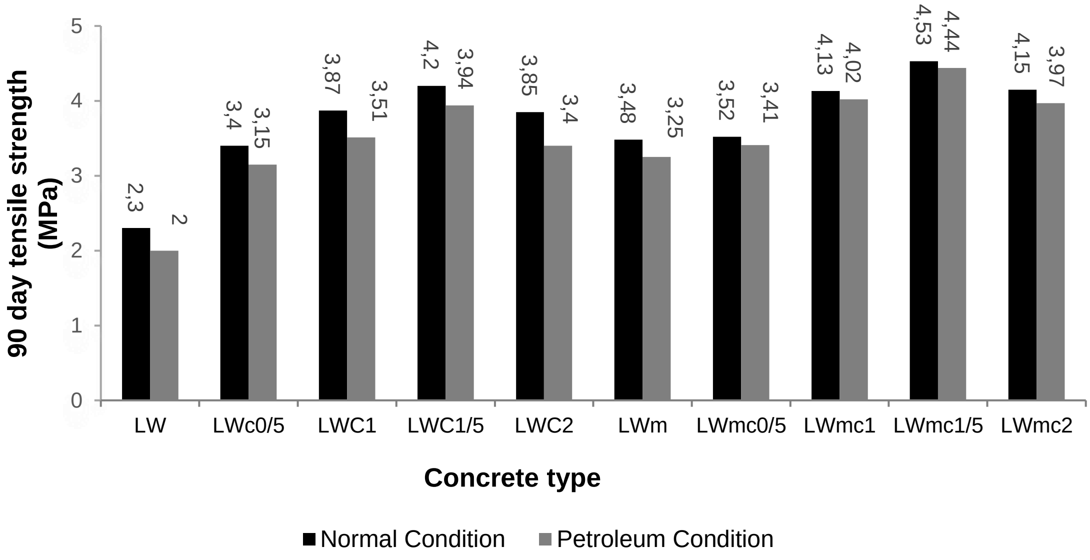

Figure 3. Comparison between the 90-day tensile strength of specimens in normal and petroleum conditions

3.3 Flexural strength

The trend of the increasing flexural strength of the fibre-containing samples compared to unmodified sample under both environmental conditions indicates the positive effect of this additive on the flexural strength of lightweight structural concrete. Studies have shown the advantage of using Kortta fibre and microsilica at the same time in improving flexural strength. According to Figure 4 addition of microsilica significantly improves the mechanical properties of concrete. Microsilica improves the flexural strength by 42 % and 41 % in normal and aggressive environmental conditions, respectively, compared to the unmodified sample. The highest flexural strength increase in normal conditions is 74 % in LWmc1,5. Considering that the use of microsilica improves the flexural strength by 42 % and the addition of fibre in LWc1,5 improves the flexural strength by approximately 44 % compared to the control sample, the concrete containing microsilica and Kortta fibre improves in strength compared to the control concrete under normal conditions. An 82 % strength increase compared to the unmodified sample is observed in LWmc1,5 under aggressive conditions, which is greater than the strength of the sample under normal conditions. This strength improvement indicates the excellent performance of these two additives together in aggressive environmental conditions, such as in oil conditions. The results of the compressive, tensile, and flexural strength of the samples show that the negative effects of petroleum substances in the process of gaining strength in 90 days are insignificant but effective. Considering this, the possibility of reducing the strength of concrete with an increase in immersion time is not far-fetched. The most important point is the method of breaking and the effects of fibre in concrete. Petroleum substances do not have any negative effect on the fibre structure; however, most of the fracture paths of concrete appear from inside the light grains.

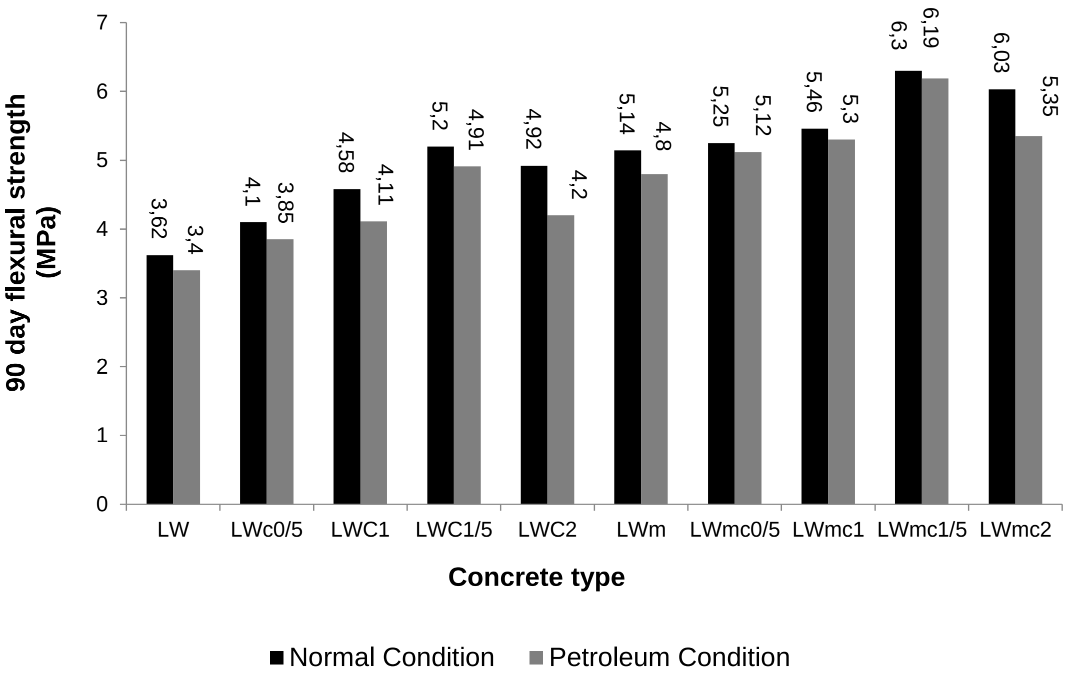

Figure 4. Comparison between the 90-day flexural strength of specimens in normal and petroleum conditions

3.4 Short water absorption

Tables 4 and 5 present the percentage of short-term water absorption of specimens modified by 2 additives in comparison with LW in normal and petroleum conditions.

Table 4. Percentage of short-term water absorption of specimens modified with 15 % microsilica and fibre in comparison with unmodified specimen (Normal conditions)

Name of Samples	90 days compressive strength	Short-term water absorption	Increase in compressive strength in comparison with unmodified concrete	Reduction in absorption in comparison with unmodified concrete
	(MPa)	(%)	(%)	(%)
LW	30,88	4,50	-	-
LWm	42,07	3,32	36,23	-26,22
LWmc0,5	44,81	3,30	45,11	-26,66
LWmc1,0	45,42	3,23	47,08	-28,22
LWmc1,5	47,34	3,17	53,30	-29,55
LWmc2,0	45,23	3,25	46,47	-27,77

Table 5. Percentage of short-term water absorption of specimens modified with 15 % microsilica and fibre in comparison with unmodified specimen (Petroleum conditions)

Name of Samples	90 days compressive strength	Short-term water absorption	Increase in compressive strength in comparison with unmodified concrete	Changes in absorption in comparison with unmodified concrete (+increase, - reduction)
	(MPa)	(%)	(%)	(%)
LW	28,20	2,00	-	-
LWm	39,46	1,30	39,92	-35,00
LWmc0,5	40,91	2,23	45,07	+11,50
LWmc1,0	42,34	2,71	50,14	+35,50
LWmc1,5	44,01	1,92	56,06	-4,00
LWmc2,0	42,31	2,30	50,03	+15,00

Compared to the unmodified specimen, permeability is reduced in all the water-cured specimens but increases in the gasoline-cured specimens, indicating the creation of rupture channels caused by gasoline. The permeability reduction of LWmc1,5 compared to LW is a noteworthy result.

As can be seen in Figure 5, compared to that of LW in normal condition the water absorption of LW in gasoline is reduced by more than 100 %. This is because the samples placed in gasoline are saturated with petroleum and still have cavities containing gasoline even after leaving the oil environment and drying. Because gasoline is a hydrophobic substance, concrete is filled with water, which results in a reduction in permeability. The specimens were kept in the laboratory after drying, which reduced the moisture, permeability, and pore size. It is also observed that adding fibre and increasing their percentage increase the permeability. As mentioned earlier, fibre reduces the permeability of water-cured specimens, but it has the opposite effect on the gasoline-cured specimens. Based the gasoline absorption test of fibre during petroleum curing, it is found that the fibres do not exhibit any gasoline absorption. As a result, it cannot be argued that the fibres lose the resistance to water penetration because of oil penetration and become a weak point in permeability in this regard. The reason refers to aggressive nature of gasoline. It reduces the adhesion resistance and thus causes greater separation between the cement paste and fibres. Gasoline permeates through the connection path between the fibre and cement matrix paste, and the capillary property causes greater separation between the cement paste and fibres. The more fibres used in the concrete, the more water absorption channels created.

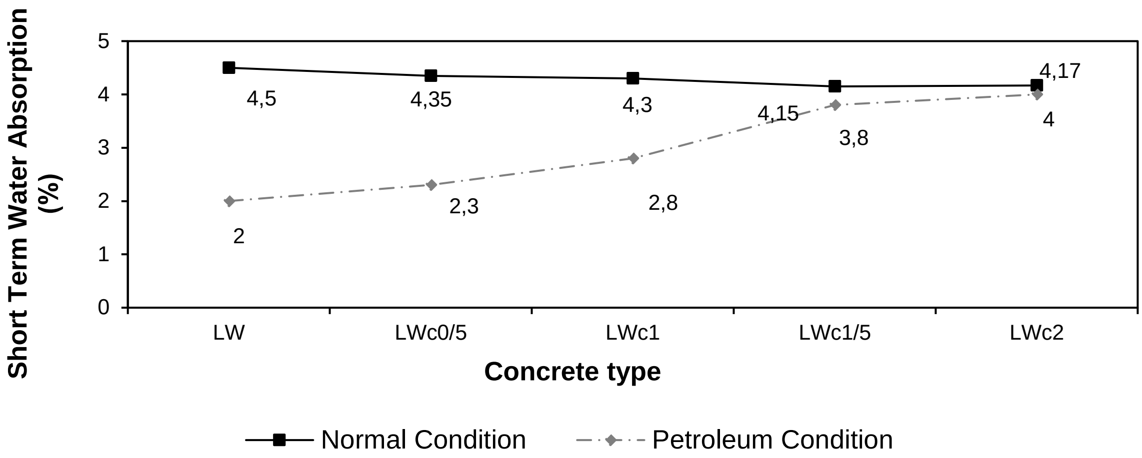

Figure 5. Comparison between short-term water absorption of specimens modified with fibres under both conditions

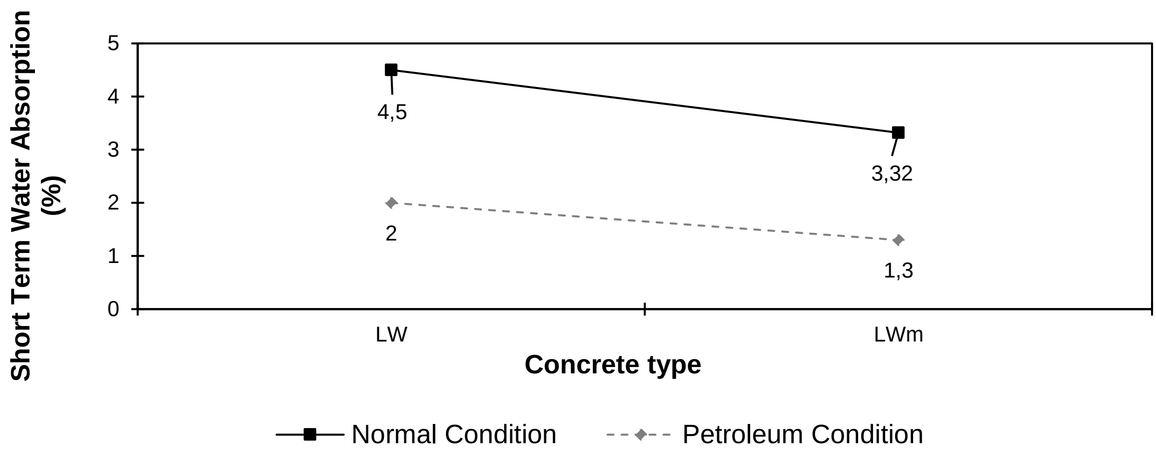

Figure 6. Comparison between short-term water absorption of specimens modified with microsilica and unmodified specimen under both conditions

According to Figure 6, microsilica also reduces the short-term water absorption of the specimens cured under both environmental conditions. This impermeability can be attributed to the increase in the penetration of the cement paste in the pores of the light grains, increase in the density of concrete, and reduction of the boundary layer between the light grains and adhesive matrix.

As shown in Figure 7, the combined addition of microsilica and fibre in normal condition reduces the permeability compared to that of the unmodified specimen. The highest percentage of permeability reduction in normal and petroleum environments is obtained in LWmc1,5 with 29,55 % and 4 % reductions, respectively, compared to that in LW. While in petroleum environmental conditions such as samples with fibre and without microsilica, the short-term water absorption increases compared to that of the control concrete in the proximity of gasoline.

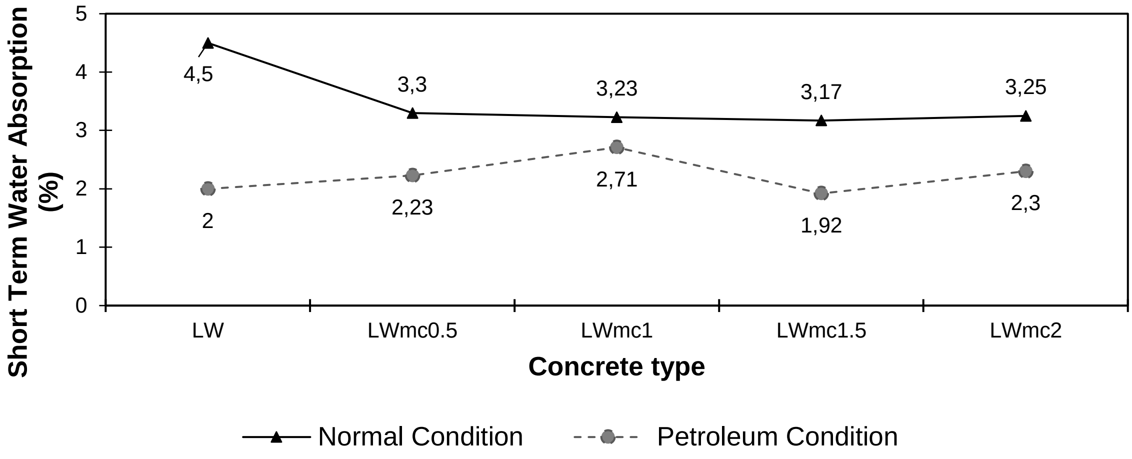

Figure 7. Comparison between short-term water absorption of specimens modified with both additives and unmodified specimen under both conditions

3.5 Gas oil absorption

As shown in Figure 8, the amount of gasoline absorption of specimens containing fibre is less than that of the unmodified specimens, and this amount decreases with increasing percentage of fibre. As mentioned before, with an increase in the number of fibre, the water absorption of the samples exposed to oil increases. This indicates the presence of pores and holes in the concrete, which implies an increase in the permeability. Therefore, the reduction in absorption of gasoline by fibre is logical and expected because all cavities of the concrete samples are not completely saturated with oil, allowing water absorption. This can be attributed to the improvement of mechanical properties of concrete specimens by addition of fibre and reduction of fluid capillaries in concrete as a result of placing the fibre in the cavity and rupture paths.

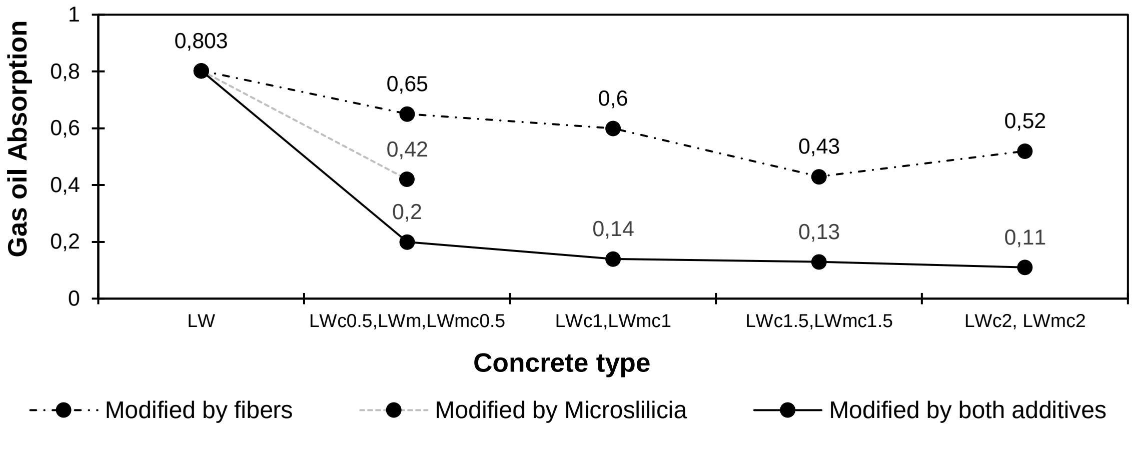

Figure 8. Comparison between gas oil absorption of specimens modified with both additives and unmodified specimen

The gasoline absorption of the microsilica-modified specimen is significantly lower than that of the control specimen, and this decrease is even lower than the reduction in the gasoline absorption in the fibre-containing specimens. By changing the cement matrix, microsilica creates a dense and integrated texture and plays a major role in permeability reduction. With increasing fibre percentage, the gasoline absorption in the samples modified with both additives decreases. It is observed that the gasoline absorption of fibre-modified specimen decreases with increasing fibre percentage owing to the improvement of the mechanical properties of the concrete specimens by the fibre. However, this percentage reduction is significantly higher than the percentage reduction of the fibre-modified samples. This is due to the presence of microsilica as a filler and compactor in concrete, which minimises the penetration of gasoline.

Figure 9 shows that the highest percentage of permeability reduction under normal conditions is obtained in LWmc1,5 with a 29,55 % reduction compared to that in control concrete. As shown in Figure 5, the addition of fibre to the samples causes a considerably smaller reduction in permeability than in the microsilica-modified sample. Therefore, these permeability reduction coefficients are not compatible with the compressive strength increase coefficients in these mixing designs. This confirms that the presence of fibre in concrete strengthens the cement matrix and improves the behaviour of concrete in compressive, tensile, and flexural stresses but does not have such an effect on the permeability and blockage of concrete cavities and pores. The low effect of Kortta fibre in reducing short-term water absorption is significant because the presence of these fibres in concrete does not lead to an increase in the percentage of absorption. Although the presence of 2 % Kortta fibre in concrete increases the permeability of concrete compared to that of LWmc1,5 concrete, it is still lower than the permeability of the unmodified and microsilica-modified concrete.

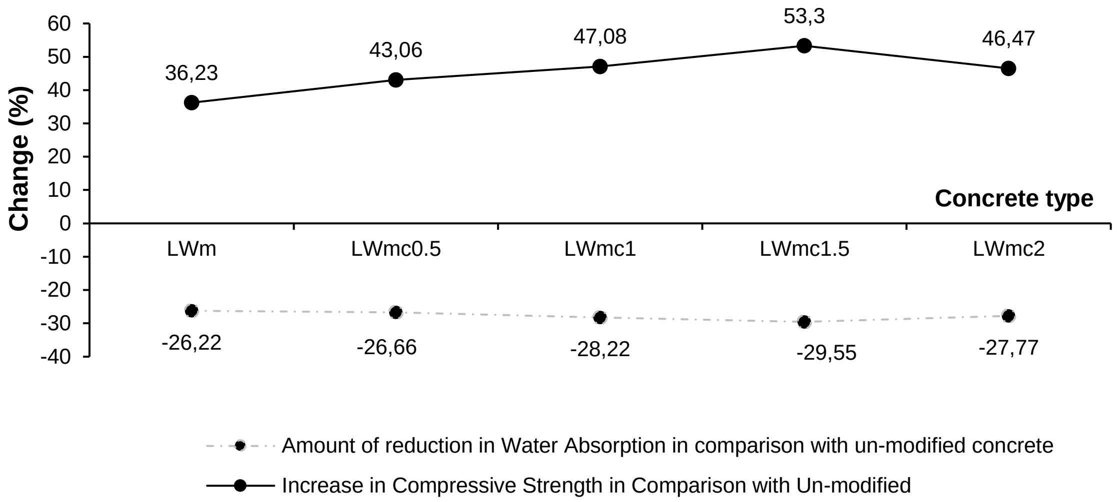

Figure 9. Changes in compressive strength and water absorption of specimens modified with both additives in comparison with unmodified specimens in normal conditions

As shown in Figure 10, in the samples exposed to gasoline the short-term water absorption of the modified specimens increases compared to that of the control specimen, which indicates the creation of rupture channels caused by gasoline. These channels or cavities can be the result of the weakness of the adhesive force due to the gasoline, leaching of the cement paste around the fibres, or the escape of oil–gas molecules from the concrete. The noteworthy observation in Figure 10 is the decrease in the permeability of LWmc1,5 compared to that of the mixed samples; a decrease of 4 % is observed compared to that of the control. The sample that exhibited the best performance in terms of compressive, flexural and tensile strength among the ten mixing designs was prepared in both environmental conditions (normal and aggressive). Therefore, its cement matrix is dense and displays minimal porosity and permeability compared to samples contains microsilica and different percentages of fibre; additionally, the fibre are stronger inside the matrix.

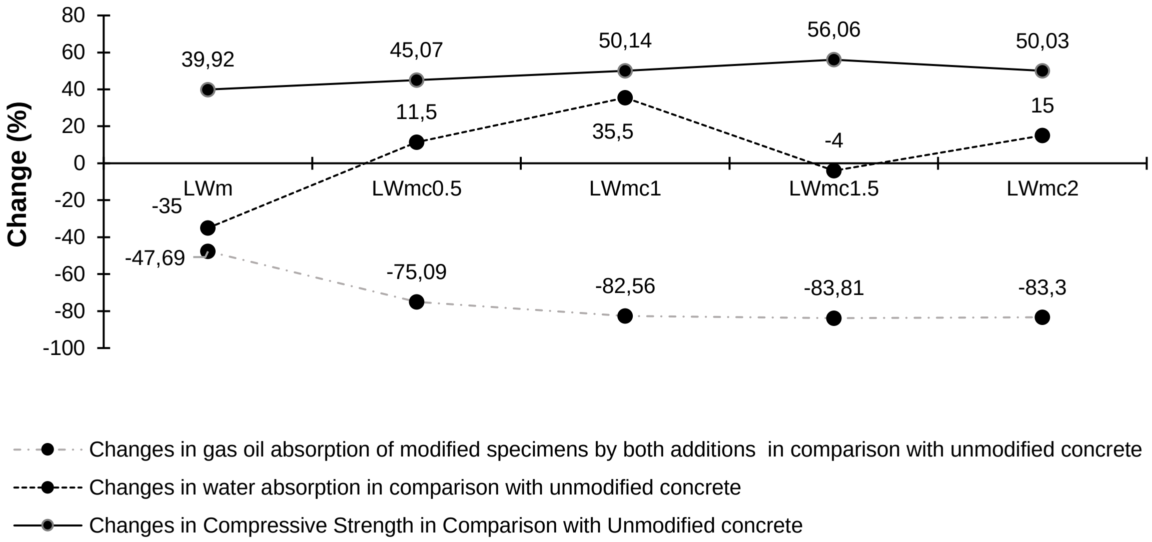

Figure 10. Changes in compressive strength and water and gas oil absorption of specimens modified with both additives in comparison with unmodified specimen in gasoline

4 Conclusions

The main objectives of this study were to create concrete with constructive concrete properties as well as fiber concrete properties and a reinforced microstructure that is usable in an aggressive environment such as in gasoline.

- By examining the compressive strength results of the LWc1,5 and LWmc1,5 concrete, it is determined that the optimal percentage of fibre in both normal and aggressive environmental conditions is 1,5; however, it is found that the presence of these fibres is not what strengthens the cement paste matrix. Because of the presence of microsilica, Kortta fibres are placed in a more sticky and stronger environment, and with the increase in stress on the concrete section, the internal structure of the concrete is preserved owing to the creation of a unified environment by the Kortta fibres; thus, only the concrete shell undergoes rupture (separation).
- The highest increase in mechanical properties of lightweight concrete is observed in the specimens containing 1,5 % Kortta fibre and 15 % microsilica in both environmental conditions.
- Increasing the percentage of Kortta fibre to 2 % reduces the compressive strength in comparison to adding 1,5 % fibre. Adding fibre in concrete and creating reinforcement in three directions can effectively improve the brittleness and resistance to the creation of small and large cracks. However, as the number of fibres increases, there is a possibility that they clump together and are interwoven or are separated from the cement matrix, which may cause inhomogeneity and separation in the cement matrix, weakening the bearing pressure and tension of the concrete matrix.
- The investigation of the effect of microsilica and fibre on the durability of concrete under aggressive curing conditions shows that their addition reduces the effect of gasoline on concrete and they complement each other; however, the effect of microsilica is significantly greater.
- The tensile strength of concrete increases with increasing compressive strength, and the highest percentage of increase in tensile strength is observed in the sample containing 1,5 % fibre and 15 % microsilica, which also displays the highest compressive strength.

- Following the increase in tensile strength in the modified specimens, the modulus of rupture or flexural strength also increases, which ultimately increases the flexural strength.
- The effect of the presence of fibre on the increase in tensile strength is greater than the effect of the presence of microsilica in concrete, and the addition of fibre alone improves the tensile strength by approximately 80 % and 95 % in normal and aggressive conditions, respectively, which emphasizes that the primary role of fibre is to improve the tensile strength and minimise cracks, while the primary role of microsilica is to increase the density and reduce the porosity of the cement matrix, thus increasing the compressive strength.
- By adding Kortta fibre and microsilica, either separately or in combination, under normal environmental conditions, permeability is reduced. However, the highest percentage of permeability reduction occurs in samples with microsilica owing to the increase in cement paste density because of the formation of silicate gel and porosity reduction.
- The type of grain used in this study is Leca, which in addition to having good mechanical characteristics has a small resistance capacity compared to ordinary aggregate and even the matrix that contains it. Therefore, the initiation and passing of the rupture path inside the Leca are inevitable, and even the addition of microsilica, strengthening of the cement matrix, and penetration of cement paste into these light grains cannot increase the effectiveness as well as the fibres that improve the tensile strength of concrete by over 80 % in both processing conditions.
- Lightweight aggregate concrete always has an adhesion strength equal to 60 to 100 % of that of normal concrete; therefore, Kortta fibres with good elasticity provide development length, and the chemical structure of its hydrophobic network of interwoven fibres stabilizes or reduces the permeability of water-cured samples. This is because if the location or percentage of fibres in the concrete is not problematic, the permeability of concrete does not increase with the addition of Kortta fibres.
- Addition of microsilica reduces the water absorption of concrete in petroleum environmental conditions. However, the addition of fibre increases this amount. This is because of the aggressive nature of gasoline. Gasoline reduces the adhesion resistance and thus causes more separation between the cement paste and fibre, which results in an increase in the water absorption channels in the concrete. In addition, by improving the mechanical properties of concrete withy microsilica and increasing the cohesiveness of the cement paste, it is natural that this material reduces the permeability of concrete.
- In general, the percentage of water absorption of the gasoline-cured samples is significantly less than that of the water-cured samples. It can be said that after the gasoline saturation of the concrete specimens and gasoline penetration into their cavities, the specimens resist water penetration due to the hydrophobicity of gasoline.
- The absorption of gasoline in samples with 15 % microsilica and without fibre shows a 47 % decrease compared to that of the unmodified sample, and this reduction becomes approximately 84 % with the addition of 1,5 % Kortta fibre in the cement matrix. The microsilicia-filling property reduces the porosity and permeability, which increases with the addition of fibre, and significantly improves the mechanical properties of concrete.
- It is crucial to note that because the proximity of concrete to gasoline slows down or stops the growth of the compressive strength of concrete, the tanks should be filled with oil at least 28 days after preparation of concrete.
- The results of the compressive, tensile, and bending strengths of the samples show that the negative effects of petroleum substances in the process of gaining strength in 90 days are insignificant but effective. This indicates that with an increase in the immersion time, the possibility of reducing the strength of concrete is not far-fetched.

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