Studying the effect of hybrid fibers and silica fumes on mechanical properties of Ultra-High-Performance Concrete

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Abstract. Through this research, the influence of different amounts of polypropylene fiber and steel fibers and with specific proportions of silica fume on the hard characters of Ultra-High-Performance Fibers Reinforced Concrete (UHPFRC) has been studied. Amounts quantities were being added polypropylene fibers (0.4% to 0.8% to 1.2%), and 16% steel fibers and with specific proportions of silica fume (20%, 25%, and 30%) to the of UHPC. This study indicates the possibility of preparation of UHPFRC mixes utilizing locally available materials at markets when careful selection is being to materials and can achieve a compression strength of (178.84) MPa, splitting tensile strength of (19.96) Mpa, and the flexural strengths of (24.97) MPa. The experimental results showed a significant improvement in the mechanical properties of the UHPFRC which contains the combination of fibers compared to UHPC mixes without hybrid fibers. Ultra-High-Performance Fibers Reinforced Concrete (UHPFRC) may also be a building material with good improved mechanical and high properties use in building and construction working and can be utilized for all applications, particularly for rehabilitation works.

1. Introduction
There were exciting innovations in concrete materials after normal concrete, such as High Strength Concrete (HSC), High-Performance concrete (HPC), and Ultra-High Strength concrete (UHPC). Such high-tech materials have tremendous application opportunities for the construction industry with the production of these concrete technologies [1]. The use of UHPFRC with higher compressive strength in the construction industry has grown worldwide in recent years because of excellent durability and high mechanical properties [2]. UHPFRC is a relatively new building material that combines high-performance concrete matrix with hybrid fibers reinforcement it has ultra-mechanical properties because of the high cement dose, low water-cement ratio, and the presence of fibers [3]. UHPC is of high dense coarse or fine structure aggregated concrete of a low ratio (water/cement) lowered than 0.30, high admixtures of minerals and cement content that selected for increasing the bond among cement paste and aggregates, this type of concrete is named Ultra High-performance Concrete [4]. Ultra-high-performance concrete is a modern building material with good and improved mechanical and durability properties that can contribute to cost-effective construction by minimizing cross-sections of structural members with related material savings and lower installation and labor costs [5]. The development of UHPC depends on its materials homogeneous and the proportioning of the mixture, these properties lead to resulted in the concrete more density and comparatively more
homogeneous, and improved the properties of Ultra-high-performance concrete lead to improve the mechanical behavior generally [6]. Silica fume optimum amount addition to concrete has several advantages imparted a lowering in the hydration heat, low permeability, and high strength of target, alkali-silica reaction initiation, and sulfate effect regulation. Also, since the interfacial aggregate paste transition zone is minimized via silica fume addition, concretes of high strength and more space-free can be achieved [7]. To make use of the wide potential of UHPC guidelines on the design and construction of UHPC structures, it is important to build, and this new material and technology should be more available to the designer’s engineers. Further scientific work on UHPC systems needs to be done, too. With all these efforts, UHPC will become a popular technology that will lead to more competitive and productive infrastructure [8]. Ultra-high performance concrete is successful in the design of concrete buildings that experience impact and high loads. In order to make Ultra-high strength concrete systems more ductile and effective, by different hybrid fiber reinforcements are integrated [9]. Fiber-reinforced concrete is concrete that contains fibrous material it comprises small, uniformly distributed, or randomly directed discrete fibers which increases the integrity of it is structure. Fibers include synthetic fibers, such as steel fibers, glass fibers, and natural fibers, etc. Each of which gives the normal or varying properties of UHPC [10]. Fiber reinforced concrete (FRC) is well-found key characters is its tolerance to cracking and propagation cracks stopping. As ability consequence to cracks arrest initially and eventually, particularly under flexural loading, fiber has increased extensibility and tensile strength, and hence the fibers will keep the matrix together even after substantial cracking [11]. UHPFRC enables the building of structural parts without the need for transverse reinforcement due to its advantageous flexural force. Because UHPC can cause longer structures of span along member sizes reduction in comparison to high or normal concrete of strength, an important minimization in self-weight and volume might be expected along UHPC members. UHPC cross-sectional area of members as compressive might be minimized in comparison to normal members concrete because of UHPC’s high strength as compressive [12]. In order to make use of the wide potential of UHPC guidelines on the design and construction of UHPC structures, it is important to build, and this new material and technology should be more available to the designer’s engineers. Further scientific work on UHPC systems needs to be done, too. With all these efforts, UHPC will become a popular technology that will lead to more competitive and productive infrastructure [13]. Because UHPC can be used to construct member sizes reduction in comparison to high or normal concrete of strength, an important minimization in self-weight and volume might be expected along with UHPC members. UHPC cross-sectional area of members as compressive might be minimized in comparison to normal members concrete because of UHPC’s high strength as compressive. The goal of this study is to develop UHPC and explain the effect of hybrid fibers (steel and polypropylene fibers) with silica fume on UHPFRC properties as compressive, flexural, and tensile strength.

2. Experimental program

Hardened concrete tests including tests of compression for indirect tensile and strength (flexural strength and split cylinder tests). Steel fibers influence and amounts of polypropylene fibers on strength concrete compression along with the UHPFRC density and workability were investigated via preparing various mixes of concrete. Procedures of test, materials, equipment, and details utilized for assessing concrete characters are shown in the sections follows.

2.1. MATERIALS

- Portland cement: is the most active component of UHPC and usually has the greatest unit cost and the test results comply with the requirements of the Iraqi Standard Specification IQS (No. 5/1984) (Portland cement) and with the ASTM C150 requirements [14], specifications for purposes of comparison.
- Quartz Sand: it is comparatively inexpensive for UHPC production. The size as nominal is ranging (0.15 to 0.6) mm. It is significant to make sure the aggregates are well clean, because of clay or silt layer reduce the cement bond aggregate strength, besides increasing demand of water, results of the sand, the limits of the Iraqi Specification (No.45/1984), and British Standards (BS 882- 1992) [15].
• Fume of Silica: It is a by-product coming from quartz reduction with wood chips and coke at arc furnace as electrical throughout silicon production or alloys as ferrosilicon. And it exists in a grey powder form that contains silicon dioxide and no chlorides or other potentially corrosive substances. The silica fume used in this investigation conforms to the requirements of (ASTM C1240-05) specifications.

• H₂O: tap H₂O was utilized in all mixtures of concrete and specimen’s tests curing.

• Superplasticizer: The admixture as chemical utilized is superplasticizer that is produced to conform to ASTM C494-2013[16] specification kinds F and G. If added to the blend of concrete, it is improving hardened and fresh concrete properties and this plasticizing impact might be utilized to elevate fresh concrete workability, rendering it powerful extremely; and H₂O minimizes to a high extent, leading to strength, high density, and ability of excellent flowing.

Table 1. Technical data for the (ViscoCrete – 5930).

| Type      | Properties                                           |
|-----------|------------------------------------------------------|
| Appearance| Turbid liquid                                        |
| Density (kg/l) | 1.08 ± 0.005                               |
| pH value  | 6.6                                                  |
| Basis     | Aqueous solution of modified polycarboxylate        |
| Toxicity  | Non-Toxic under relevant health and safety codes     |

• Polypropylene fibers (PP.F): It is a plastic polymer used in the construction industry to enhance the resistance of concert. It is not hydrophilic- polypropylene fibers do not absorb water as a result of malicious. These fibers are resistant to alkalies, chemicals, chloride, and heat transfer properties. Among the properties of PP.F is that it does not absorb water, that is, polypropylene fibers do not need to bother to mix cement with water. Table 2 shows the property of the used polypropylene in this research work. ASTM C-1116-1997 [17].

Table 2. Properties of polypropylene fibers.

| NO | Property          | Polypropylene |
|----|-------------------|---------------|
| 1- | Specific gravity  | 0.91          |
| 3- | Fiber diameter    | 38 µm         |
| 4- | Fiber length      | 12mm          |
| 5- | Tensile strength  | 320-400 MPa   |
| 6- | Melting point     | 160-170 ºC    |
| 7- | Sulfate           | Nil           |

Figure 1. Polypropylene Fibers.

• Steel fibers (SF): these have a high modulus and strain to failure due to the high tensile strength and good formability; therefore, they are considered as one of the best and most economical fiber
types. The steel fibers used in UHPFRC, exhibit a high tensile strength as well as to study the effect of using it in improving the resistance for the ultra-high-performance concrete and the all properties of the steel fibers are given as in Table 2.

Table 3. Properties of steel fibers.

| NO. | Properties         | Steel fibers |
|-----|--------------------|--------------|
| 1-  | Length (mm)        | 13 mm        |
| 2-  | Diameter (mm)      | 0.20 mm      |
| 3-  | Density (gm/cm³)   | 7.8 g/cm³    |
| 4-  | Tensile strength   | 655 MPa      |
| 5-  | Shape              | Straight     |

2.2 Specimens

UHPFRC specimens were cast and tested. A total of (72) cube 100 × 100 × 100 mm and (36) prisms 100 × 100 mm cross-section and 400 mm length and (36) cylinders 300mm length and 150 mm Diameter cylinders of UHPFRC specimens were cast and tested in this research. These UHPFRC specimens were arranged into eight groups shown as shown in Table 4 and 5. These eight group cubes of UHPC, in the beginning, tested the compressive strength flexural strength and tensile stresses strength.

2.3 Testing program

The effect of the hybrid fibers (Polypropylene and steel fibers) was studied on the UHPC to obtain the optimum percentage for the mix by preparing different mixes with different percentages of polypropylene and steel fibers shown in Table 5, and 4. The properties of the different constituent materials used to produce UHPC have also discussed the details of the test's procedure. UHPC c materials utilized in this work included ordinary cement as Portland, quartz sand, fume of silica, polypropylene, and fibers of steel. Also, a superplasticizer was used to ensure suitable workability.

Table 4: One cubic meter components of UHPFRC mixture (Kg/m3)

| No. | Materials         | (Kg/m3) |
|-----|-------------------|---------|
| 1-  | Cement            | 900     |
| 2-  | Quartz Sand       | 1125    |
| 3-  | water             | 216     |
| 4-  | Super plasticizer | 27      |
| 5-  | Steel             | 144     |
| 6-  | Silica Fume       | 180 225 270 |
| 7-  | Polypropylene     | 3.6 7.2 10.8 |
As stated before, this research aims to study the effects of adding polypropylene and steel fibers on the resistance of Ultra-High-Performance Concrete (UHPC) using locally available materials. The tests for hardened concrete included compressive flexural strengths and splitting tensile strength of the concrete.

### 2.3.1 Compression Test of UHPFRC

One of the most important tests for concrete is the compressive strength; this test was done according to the [ASTM C109, 2008 ASTM C109/C109M, 2008]. Many mixture trials were prepared for every UHPFRC batch made, (100x100x100) mm, cubes of concrete were prepared. For each group, three samples were prepared and tested to obtain the averaged value. The compressive specimen strength $\sigma_{\text{comp}}$ in MPa can be detected by maximum load division over the loaded area:

$$\sigma_{\text{comp}} = \frac{P}{A}$$  \hspace{1cm} (1)

Where: $P =$ maximum load performed via the cube specimen throughout test.

A = cross-sectional specimen area

### 2.3.2 UHPFRC Splitting Cylinder Test

UHPFRC splitting strength tensile was calculated according to (ASTM C496, 2004), the test as a standard procedure for cylindrical specimens concrete measures tensile resistance. The tensile concrete strength is measured indirectly via cylinder compressing at width. The specimen causes tensile and shear stress on the interior of the specimen's aggregate particles, causing failure of bond between paste of cement and particles aggregate. Normally, the shear resistance given by concrete components is measured using a splitting tensile strength test. Where specimen being cylindrical is put on its side and held in diametric compression. The applied load to specimen of concrete cylindrical applies tensile stresses on plane having compressive stresses being relatively high and load in the area immediate around. As compressing applied over the cylinder by 2 faceplates being plane-parallel, positioned at 2 diametrically opposite surface points of cylinder, then the main tensile stresses are formed along the diameter going through the two points, to reach the fracture strength value, ASTM C496 indicates that the maximum fracture strength can be calculated based on the following equation.

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### Table 5. UHPFRC Mixes Used in This Research /Cement content percentage.

| Material Name Mix. | Cement | Quartz | Silica Fume | Super plasticizer | Water | SF | PPF |
|--------------------|--------|--------|-------------|-------------------|-------|----|-----|
| Mix. 0-1           | 1.00   | 125%   | 20%         | 3%                | 24%   | 0.0%| 0.0%|
| Mix. 0-2           | 1.00   | 125%   | 25%         | 3%                | 24%   | 0.0%| 0.0%|
| Mix. 0-3           | 1.00   | 125%   | 30%         | 3%                | 24%   | 0.0%| 0.0%|
| Mix. 1-1           | 1.00   | 125%   | 20%         | 3%                | 24%   | 16% | 0.4%|
| Mix. 1-2           | 1.00   | 125%   | 25%         | 3%                | 24%   | 16% | 0.4%|
| Mix. 1-3           | 1.00   | 125%   | 30%         | 3%                | 24%   | 16% | 0.4%|
| Mix. 2-1           | 1.00   | 125%   | 20%         | 3%                | 24%   | 16% | 0.8%|
| Mix. 2-2           | 1.00   | 125%   | 25%         | 3%                | 24%   | 16% | 0.8%|
| Mix. 2-3           | 1.00   | 125%   | 30%         | 3%                | 24%   | 16% | 0.8%|
| Mix. 3-1           | 1.00   | 125%   | 20%         | 3%                | 24%   | 16% | 1.2%|
| Mix. 3-2           | 1.00   | 125%   | 25%         | 3%                | 24%   | 16% | 1.2%|
| Mix. 3-3           | 1.00   | 125%   | 30%         | 3%                | 24%   | 16% | 1.2%|
2.3.3. UHPFRC Splitting Cylinder Test. Concrete specimens flexural strengths were evaluated via simple beam use with one loading center-point in accordance with [ASTM C93/C93M, 2010] [18]. Many mixture trials were prepared. For every made batch of UHPFRC, (100x100x400) mm, prisms of concrete were prepared. For each group, three samples were prepared and tested in order to obtain the averaged value. The specimen is a beam of (100 x 100 x 400) mm; a single layer, the mold is filled, with no rodding or compacting, and immersed then in H2O at 25ºC. The cast specimen's beam is examined turned on sides respecting molded position. Such must provide plane, smooth, and parallel loading faces when any incrustations or loose sand grains are removed from faces in contact with the bearing load application points and support surfaces. Loading tool in middle point is mounted under head being spherical. Sample tested is turned on its side about its location as molded and mounted on supports of test system. Such serves plane, smooth, and parallel loading faces. The longitudinal sample centerline is directly set above both supports midpoint. Loading of sample is continuously and with no shock till rupture occurring. Ultimately, load as maximum mentioned via testing recorded machine. The flexural beam strength, Fr (in MPa), is measured as following:

\[
F_{sp} = \frac{2P}{\pi DL} \tag{2}
\]

Where:  
P: fracture force of compression behaving with cylinder  
D: diameter of cylinder;  
\( \pi = 3.14 \):  
L: length of cylinder.

\[
F_r = \frac{3PL}{2BD^2} \tag{3}
\]

Where:  
P = load as maximum mentioned via testing recorded machine,  
L = length of span,  
B = is an average specimen width, at fracture point,  
D = average depth of at fracture point.

Specimens as all beams were examined following twenty eight days from casting. Beams (3 ones) were examined for every patch, the mean specimens values considered as flexural beam strength. Following twenty four h from casing, wholl concrete samples were placed inside the curing tank. At the stated period, wholl samples stayed in the curing basin until testing time. Laboratory basin cure condition followed the (ASTM C192, 2008). The temperature of the curing water is around 25C.

### 3. Experimental results tests and discussion

Laboratory exams were performed for evaluating hardened (UHPFRC) characters. Mean results for concrete mixtures at ages 28 days are summarized in the tables, and figures. Results are the compressive strength, splitting tensile strength, and Flexural strength tests.

| Name Mix. | Steel Fibers % | Polypropylene Fibers % | Silica Fume | Compressive strength (Mpa) | 7 day | 28 day |
|-----------|----------------|-------------------------|-------------|--------------------------|-------|--------|
| Mix. 0-1  | 0.0%           | 0.0%                    | 20%         | 88.76                    | 132.65|        |
| Mix. 0-2  | 0.0%           | 0.0%                    | 25%         | 96.19                    | 136.72|        |
| Mix. 0-3  | 0.0%           | 0.0%                    | 30%         | 90.18                    | 135.61|        |
| Mix. 1-1  | 16%            | 0.4%                    | 20%         | 103.5                    | 152.23|        |
| Mix. 1-2  | 16%            | 0.4%                    | 25%         | 107.8                    | 163.47|        |
| Mix. 1-3  | 16%            | 0.4%                    | 30%         | 106.9                    | 159.64|        |
| Mix. 2-1  | 16%            | 0.8%                    | 20%         | 111.4                    | 171.43|        |
| Mix. 2-2  | 16%            | 0.8%                    | 25%         | 116.5                    | 178.84|        |
| Mix. 2-3  | 16%            | 0.8%                    | 30%         | 112.8                    | 173.75|        |
| Mix. 3-1  | 16%            | 1.2%                    | 20%         | 109.1                    | 165.43|        |
| Mix. 3-2  | 16%            | 1.2%                    | 25%         | 110.5                    | 168.56|        |
| Mix. 3-3  | 16%            | 1.2%                    | 30%         | 109.8                    | 167.12|        |
3.1 Compressive strengths for samples

The results showed Compressive strengths for samples of Ultra-High-Performance (FRC) (UHPFRC) as in Table 6 shown below:

![Compressive Strength Chart](image-url)

**Figure 3.** Compressive strengths for samples (28 days).

Results are shown in table 6 and Figure 3 demonstrates the possibility for developing UHPC with various polypropylene and steel amounts of fibers with specific proportions of silica fume in the 28 days age.

It is noticed the compressive strength for a mix without fibers (Mix. 0-1, Mix. 0-2, and Mix. 0-3) were increased by 29.2% when 0.8% polypropylene, 16% steel fibers are used, when 20% silica fume is used, by 30.1% when 0.8% polypropylene 16% steel fibers are used, when 25% silica fume is used, and by 28.1 % when 0.8% polypropylene, steel fibers, and when 30% silica fume is used such as (Mix. 2-1, Mix. 2-2, and Mix. 2-3 ) respectively.

From the above, it was observed that adding the optimum percentage of steel fibers by (16%) and polypropylene fiber (0.8%) and when 25% silica fume is used, increases affect the polypropylene and steel fibers on compressive strength of UHPFRC; it gives the best results in the compression-resistant Ultra-High Performance (FRC). The sample made of UHPFRC containing mixture fibers show ductile behaviors, and hence improving compressive strength, and also, the samples without hybrid fibers ended with sudden brittle failure. This can be explained that the fume of silica functions on 2 levels, the reaction as Pozzolanic, and the function as physical. Cement hydration yields several compounds; such as (C-S-H) and (CH). When silica fumes are added to the concrete as fresh, it reacts chemically with these compounds, that improving the bond between aggregate and cement, such duty is named packing of particle, which refining the concrete ‘micro-structure; therefore, creating a much denser structure of concrete. If silica fume 25% significantly elevated, strength declines, which might be explained that fume of silica may react to a level, following that fume of silica is not participating in reaction of hydration and stay inert at concrete being weakest point.

Nevertheless, it can be noticed that main factor in reducing the compressive strength with increased polypropylene fibers percentage due to some voids formed in the concrete matrix by polypropylene fibers, and can be in increased porosity in proportion to the increase in the amount of polypropylene fibers, or the probability of accumulation increases and the act of the accumulation that leads to weak bonding, such as noticed in (Mix. 3-1, Mix. 3-2, and Mix. 3-3) respectively. Ultimately, the foregoing results indicate that mixtures might achieve a Compressive UHPFRC strength specimens of (178.84) MPa at 28 days. Where the curing was done at room temperature via water immersion. The results were identical to those of the researchers such as (R. Yu, P. Spiesz, and H. J. H. Brouwers, and D. Y. Yoo and N. Banthia).
3.2 Splitting Tensile strengths for samples.
The results showed splitting tensile strength of UHPFRC as in table 7 and Figure 4 shown below:-

| Name Mix. | Polypropylene Fibers % | Steel Fibers % | Silica Fume % | splitting tensile strengths 28 day (Mpa) |
|-----------|------------------------|----------------|---------------|----------------------------------------|
| Mix. 0-1  | 0.0%                   | 0.0%           | 20%           | 11.56                                  |
| Mix. 0-2  | 0.0%                   | 0.0%           | 25%           | 12.11                                  |
| Mix. 0-3  | 0.0%                   | 0.0%           | 30%           | 11.89                                  |
| Mix. 1-1  | 0.4%                   | 16%            | 20%           | 14.12                                  |
| Mix. 1-2  | 0.4%                   | 16%            | 25%           | 16.52                                  |
| Mix. 1-3  | 0.4%                   | 16%            | 30%           | 15.83                                  |
| Mix. 2-1  | 0.8%                   | 16%            | 20%           | 17.06                                  |
| Mix. 2-2  | 0.8%                   | 16%            | 25%           | 18.65                                  |
| Mix. 2-3  | 0.8%                   | 16%            | 30%           | 17.76                                  |
| Mix. 3-1  | 1.2%                   | 16%            | 20%           | 18.81                                  |
| Mix. 3-2  | 1.2%                   | 16%            | 25%           | 19.96                                  |
| Mix. 3-3  | 1.2%                   | 16%            | 30%           | 19.41                                  |

**Table 7.** Splitting tensile strengths for samples.

It can be observed that adding a mixture of polypropylene and steel fibers and with specific proportions of silica fume effectively increases the splitting tensile strengths of concrete. Also, it might be noticed that elevating content of polypropylene from (0.4% to 0.8% to 1.2%), and 16% steel fibers it effectively increases the flexural tensile strengths of concrete when it was used alone without fibers. Where it is noticed the splitting tensile strength to mix without fibers (Mix. 0-1, Mix. 0-2, and Mix. 0-3) were increased by (62.7%, 64.8%, and 63.2%) respectively, when used 1.2% polypropylene and 16% steel fibers, and (20%, 25%, and 30%) of silica fume, such as noticed in (Mix. 3-1, Mix. 3-2, Mix. 3-1). We conclude from the above the optimum percentage of polypropylene, steel fibers recommended, and silica fume to be used based on this investigation for improving the concrete splitting tensile resistance is 1.2% polypropylene and 16% steel fibers and 25% silica fume, from the percentage of the cement used. The tensile strength of UHPC with fibers has a significant increase compared to non-fiber concrete and also with increasing the ratio of fibers to the perfect ratio, the tensile strength increases. It might be reported that the larger is the amount of steel fiber, the larger is splitting strength tensile. The results obtained might be explained; the hybrid fibers addition (steel fibers and Polypropylene) along tensile strength, homogenously distributed within each batch will sustain the developed stresses of tensile, therefore elevating the splitting specimen's tensile strength.
This indicates that the fibers at the microscopic level, it has been able to achieve acceptable adhesion and elevate strength of tensile finally; the foregoing results indicate that mixtures can accomplish a mean tensile splitting strength 19.96MPa specimens UHPFRC at 28 days. At 25°C Curing was occurred via water immersion.

3.3 Flexural strengths for samples
Results are shown below in Table 8 and Figure 5 demonstrates the possibility for developing UHPFRC with various polypropylene and amounts of fibers as steel.

| Name Mix. | Polypropylene Fibers % | Steel Fibers % | Silica Fume % | Flexural Strength 28 day (Mpa) |
|-----------|------------------------|----------------|--------------|-------------------------------|
| Mix. 0-1  | 0.0%                   | 0.0%           | 20%          | 14.88                         |
| Mix. 0-2  | 0.0%                   | 0.0%           | 25%          | 15.62                         |
| Mix. 0-3  | 0.0%                   | 0.0%           | 30%          | 15.22                         |
| Mix. 1-1  | 0.4%                   | 16%            | 20%          | 18.75                         |
| Mix. 1-2  | 0.4%                   | 16%            | 25%          | 20.76                         |
| Mix. 1-3  | 0.4%                   | 16%            | 30%          | 19.32                         |
| Mix. 2-1  | 0.8%                   | 16%            | 20%          | 21.85                         |
| Mix. 2-2  | 0.8%                   | 16%            | 25%          | 23.89                         |
| Mix. 2-3  | 0.8%                   | 16%            | 30%          | 22.35                         |
| Mix. 3-1  | 1.2%                   | 16%            | 20%          | 22.91                         |
| Mix. 3-2  | 1.2%                   | 16%            | 25%          | 24.97                         |
| Mix. 3-3  | 1.2%                   | 16%            | 30%          | 23.93                         |

![Figure 5. Flexural strengths for samples (28 days).](image)

It was observed that adding a mixture of polypropylene and steel fibers and with specific proportions of silica fume effectively increases the flexural tensile strengths of concrete. Also, it can be noticed that elevating content of polypropylene from (0.4% to 0.8% to 1.2%), and 16% steel fibers it effectively increases the flexural strengths of concrete when it was used alone without fibers. Where it is noticed the flexural tensile strength to mix without fibers (Mix. 0-1, Mix. 0-2, Mix. 0-3) were increased (53.9%, 59.8%, and 57.2%) respectively, when used 0.8% polypropylene and 16% steel fibers, and (20%, 25%, and 30%) of silica fume, such as noticed in (Mix. 3-1, Mix. 3-2, Mix. 3-3). We conclude from the above the optimum percentage of polypropylene, steel fibers recommended, and silica fume to be used based on this investigation for improving the UHPFRC flexural resistance is 0.8% polypropylene and 16% steel fibers and 25% silica fume, from the percentage of the cement used.

It might be concluded that the higher is the amount of mixtures fibers, the higher is the strength as flexural, and if fume of silica elevated from 20% to 25% the strength elevated, while if the amount is
more than 25%, the strength as flexural declined. Results obtained may be explained as a better bonding is developing because of using of fume of silica along fibers, that is the most effectively for getting ITZ (ITZ) denser, it blocks several high pores in such zone and elevates bond strength between fibers and cement paste, therefore declining cement paste pores, in which fibers addition homogenously distributed within each batch and function as a reinforcement, will sustain the developing stresses of tensile therefore elevates UHPFRC specimens flexural strength. This indicates that the fibers at the microscopic level, it has been able to achieve acceptable adhesion and elevates finally the strength of tensile; the foregoing results illustrate that mixtures can accomplish a mean tensile flexural strength of UHPFRC 24.67MPa specimens at 28 days.

3.4 Effects of polypropylene, steel fibers, and silica fume on unit weight concrete
The obtained data illustrate UHPFRC density declines if elevating polypropylene fiber percentage in the mix, it is due to the increase in porosity in the sample. Also, obtained data illustrate UHPFRC density declines if elevating content of fume of silica, while it elevates if steel fibers amount elevates.

4. Conclusion
The objective of this research is to study the effects of adding available materials to the concrete mixes and designing these mixes with the optimum amount of polypropylene and steel fibers on-resistance of (UHPC) occurrence of failure. Our trial concentrated on developed UHPFRC and properties for mechanical such as compressive, relatively high flexural strength and tensile, porosity being low.

- Experimental results show the significant improvement of the residual mechanical properties of UHPFRC containing the mix of fibers (polypropylene and steel fibers) compared to UHPC without adding polypropylene and steel fibers. For steel fibers content are 16% and polypropylene fibers 0.8% and 25% silica fume by the total weight of cement produced very high compressive strength UHPFRC with 178.84MPa.
- The higher the fiber of steel and content of polypropylene fibers, the higher splitting strength tensile if used steel fibers content is 16% and polypropylene fibers 1.2%, and 25% silica fume by the total weight of cement. High splitting tensile strength concrete with 19.96 MPa and flexural strength concrete with 24.97 MPa because it is working as developed tensile stresses reinforcement sustaining.
- Increasing the silica fume content in UHPFRC from 20% to 25% effectively increases the compressive strength, splitting tensile strength, and the flexural strength of UHPFRC. But increasing the silica fume content from 25% to 30% decreases the compressive strength.
- The experimental results show an increase in all cases of tensile strength in parallel with the increase in the amount of fibers has been. This indicates that the fibers at the microscopic level, it has been able to achieve acceptable adhesion and increase the tensile strength. In general, adding the right amount of fibers to the concrete. It has a good effect on tensile strength.
- It should be noted that amount of fibers should not exceed a certain amount because, the probability of accumulation increases and the act of accumulation is caused by weak bonding, so it will be necessary to determine the optimal amount.
- It is inferred that fiber concrete can be used in concrete works to increase ductility and safety due it indicates an increase in the adhesion strength of fiber concrete. On the other side, it helps prevent it fall out components after failure. And it is one of the most effective and economical ways of growing surface erosion resistance and managing surface cracks.
- The results show that the hybridization of two fiber forms-steel and polypropylene-greatly improves the UHPC durability. UHPC's mechanical properties with hybrid fibers are superior to UHPC, reinforced with only one form of fibers-especially in terms of improved flexural strength and durability. Also, adding fibers to UHPC will alter crack patterns, restrain the crack emergence, and inhibit the concrete specimen crack expansion.
- The data indicate that UHPFRC density declines if elevating polypropylene fibers percentage in the mix, it is due to the increase in porosity in the sample. But it elevates when the amount of steel
fibers elevates whereas having other contents constant and the UHPFRC densities decrease as silica fume content elevates while having other contents constant.

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