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Effect of Different fibers on Punching shear capacity

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ABSTRACT

This study explores the application of various fibres to augment the punching shear capability of flat slabs. The incorporation of hybrid fibres in concrete mixes necessitates careful evaluation of the distinct characteristics and advantages offered by each type of fibre in concrete. A total of eight mix elements, each measuring 150x150x150 mm in cube form and 150x300 mm in cylindrical form, were subjected to concentric loading conditions until fracture occurred. T We classified the mixtures into three categories to examine the impact of various types and quantities of fibres. The test results showed that slab elements with three types of hybrid fibres (mix 7) have a punching shear capacity that is 10% to 13.2% higher than slab elements with only two types of hybrid fibres. Conversely, the combinations of two different types of hybrid fibres resulted in a punching shear capacity that was 8% greater than that achieved with only one type of fibre. Additionally, there was a 15% reduction in deflection and a 12% increase in stiffness. The mix with three hybrid fibers had a 70% higher maximum punching strength and a 54% higher energy absorption rate than the control slab, which didn't have any fibers. Additionally, the same mix reduced the deflection by 52% compared to the control mix.

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I. Introduction

Concrete is widely recognized as a fundamental building material due to its versatility, durability, and cost-effectiveness in construction projects. Over the years, researchers and engineers have continuously sought to enhance the mechanical properties of concrete to meet the evolving demands of modern infrastructure. Among the various methods explored for improving concrete performance, the incorporation of fibers has emerged as a promising approach. [1-10].

This introduction provides an overview of the influence of steel, Polyvinyl Alcohol (PVA), and glass fibers on the compressive and tensile strength of concrete. Steel fibers, typically manufactured from high-strength steel, are widely used to reinforce concrete structures, offering improved resistance to cracking and enhanced ductility. Polyvinyl Alcohol (PVA) fibers, known for their high tensile strength and compatibility with cementitious matrices, contribute to increased tensile strength and crack resistance in concrete. Glass fibers, characterized by their exceptional tensile strength and stiffness, are also utilized to enhance the mechanical properties of concrete, [11-14].

Understanding the individual and combined effects of these fibers on concrete properties is essential for optimizing concrete mix designs and achieving desired performance characteristics. By enhancing both compressive and tensile strength, these fibers play a critical role in improving the overall durability, resilience, and sustainability of concrete structures, [15-20].

This review aims to comprehensively analyze the impact of steel, PVA, and glass fibers on the mechanical properties of concrete, focusing specifically on their influence on compressive and tensile strength. By synthesizing existing research findings and identifying gaps in knowledge, this review seeks to provide insights that can guide future research endeavors and inform engineering practices in the construction industry. Through a deeper understanding of the effects of fiber reinforcement on concrete performance, engineers and researchers can develop innovative solutions to address the challenges of modern construction and create more robust and resilient infrastructure, [21-22].

II. Experimental Program:

- **Objective of the Experimental Program**

The main objective of this study is to investigate behavior of fiber concrete.

The various specific objectives are:

1. Studying the behavior of fiber concrete.
2. Investigate to optimum minimum reinforcement ratio with minimum crack width UHSC beams.
3. Investigate the others cross section on UHSC

• Details of Test Specimens

The experimental program was conducted on Eight specimens. All specimens with three cubes and three cylindrical projections at each end as shown as detailed at Table.1

TABLE I
DETAILS OF TEST SPECIMENS

mix	Volume of fiber and type	Cube (mm)	Cylindrical(mm)
control	----------	150*150*150	300 *150
Mix 1	0.5% Steel	150*150*150	300 *150
Mix 2	0.5 %PVA	150*150*150	300 *150
Mix 3	0.5 % Glass	150*150*150	300 *150
Mix 4	1 % steel	150*150*150	300 *150
Mix 5	1% PVA	150*150*150	300 *150
Mix 6	1 % glass	150*150*150	300 *150
Mix 7	0.5% PVA ,0.5% steel ,0.5% glass	150*150*150	300 *150

• Experimental materials

Sand:

its granules must be gradual in size, coarse, and free from fine, clay or organic materials, and its composition must be free of salts (because they have a bad effect on the strength of concrete).

It is preferable to use light yellow sand and avoid dark brown. As shown in fig.1

Fig. 1. Sand

2- gravel:

It must meet the same specifications as sand in terms of gradation in the size of the particles and free from fine materials and salts.

We can obtain it directly from nature or by crushing the rocks in dedicated crushers to obtain the required volume gradient.

Large aggregate sieves (salt): including sieves (40-20-10-5) mm Sizes 10 and 20 mm were used. As shown in fig 2.

Fig. 2. Gravel

3.water

Water is an essential element in construction work of all kinds, whether in the manufacture of manufactured materials or the preparation of mortar used in construction and concrete works.

4-cement

Ordinary Portland cement is an excellent commonly used building material due to the excellent bonding properties that give strength to structural elements. As shown in fig3.

Fig.3. Cement

4-plasticizer:

It is a strong plasticizer that has an effect on all efficiency to produce smooth and run-down concrete in hot weather, and also as a key factor for reducing water.AS shown in fig4.

Fig.4. Plasticizer.

- **casting and curing mix**

Cairo University's laboratory was the site of the concrete mixture preparation. In order to replicate the pouring sequence for flat slabs, three layers of formwork were built. An electrical vibrator was used to compact and consolidate each layer of concrete, minimizing air voids and ensuring correct consolidation. The curing phase, which lasted for 28 days, began after the slabs were taken out of the formwork and deposited in the laboratory after 48 hours. The steps involved in getting a specimen ready are shown in Fig 5. (a,b,c)

a. Curing cubes and cylindrical

b. mix

c. After casting in cubes and cylindrical

III. Test the cubes and cylindrical

- **Tensile Strength**

As shown in fig.6 test the cubes for tensile strength.

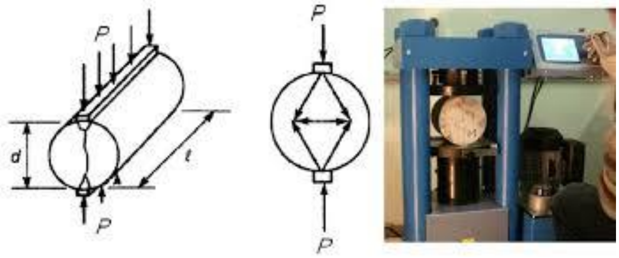

Fig.6. tensile strength test.

- **Compressive Strength.**

As shown in fig.7 test the cubes for Compressive strength.

Fig.7. compressive strength test.

V. Results

Overall, the synergistic effects of combining steel, PVA, and glass fibers in concrete mixes result in materials with superior mechanical properties. These enhanced properties include increased compressive and tensile strength, improved ductility, and enhanced resistance to cracking and impact. Such improvements are crucial for the development of durable and resilient concrete structures capable of

withstanding the challenges of modern construction environments.

In conclusion, the findings of this review underscore the importance of fiber reinforcement in enhancing the mechanical performance of concrete. By understanding the individual and combined effects of steel, PVA, and glass fibers, engineers and researchers can optimize concrete mix designs to meet specific project requirements and achieve desired performance objectives. Moving forward, further research and experimentation are warranted to explore optimal fiber combinations, dosage levels, and application techniques to maximize the benefits of fiber-reinforced concrete in real-world construction applications.as shown results in Table 2,fig.8 and fig.9.

TABLE 2
RESULTS OF MIXES

MIX	control	MIX 1	MIX 2	MIX 3
Compression Strength (N/mm^2) (f_{cu})	45	46.21	44.70	45.14
Tensile Strength (N/mm^2) (f_t)	2.97	4.4	3.21	6.21
MIX	**MIX 4**	**MIX 5**	**MIX 6**	**MIX 7**
Compression Strength (N/mm^2) (f_{cu})	8.67	46.21	44.70	47.14
Tensile Strength (N/mm^2) (f_t)	8.67	6.54	12.56	14.21

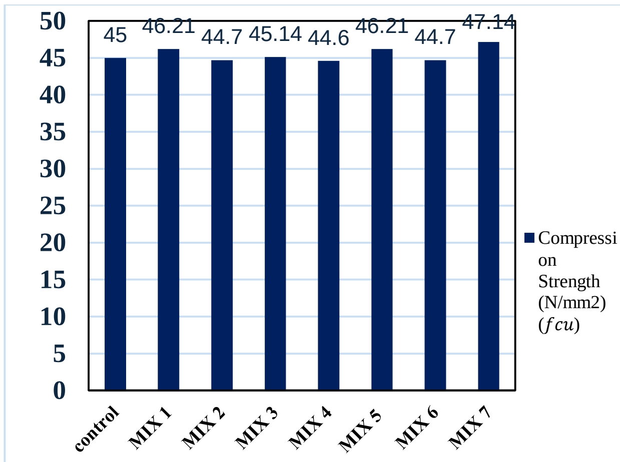

Fig8. Comparison between mixes in compression strength.

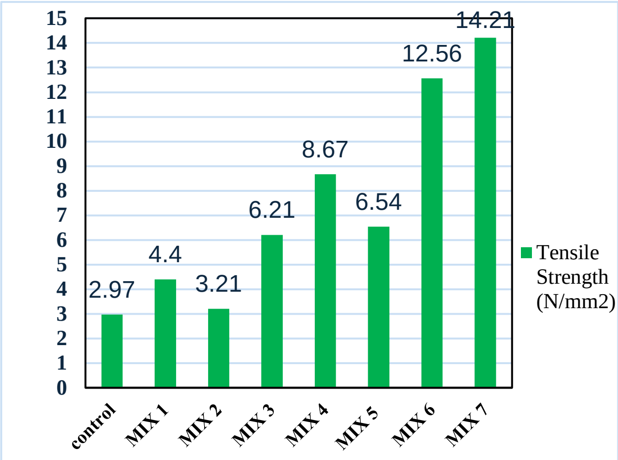

Fig9. Comparison between mixes in tensile strength.

VI. Conclusion

The investigation into the effects of steel, Polyvinyl Alcohol (PVA), and glass fibers on the compressive and tensile strength of concrete yields valuable insights into the enhancement of concrete performance. Through a comprehensive review of existing literature and research findings, several key conclusions can be drawn.

1- the incorporation of steel fibers into concrete mixes significantly improves both compressive and tensile strength. Steel fibers act as reinforcement, effectively redistributing stress within the matrix and enhancing the material's ductility and toughness. This reinforcement mechanism mitigates crack formation and propagation, resulting in concrete structures that exhibit enhanced resilience and durability.

2- Polyvinyl Alcohol (PVA) fibers offer notable improvements in tensile strength and crack resistance when added to concrete mixes. Their high tensile strength and compatibility with cementitious matrices contribute to the formation of a robust network of reinforcement within the concrete matrix. This reinforcement network effectively bridges micro-cracks, enhancing the material's flexural strength and durability.

3- the inclusion of glass fibers in concrete mixes enhances both tensile strength and toughness. Glass fibers, characterized by their exceptional tensile strength and stiffness, effectively resist tensile forces and improve the crack resistance of concrete structures. Additionally, the high modulus of elasticity of glass fibers contributes to the stiffness of the concrete matrix, further enhancing its mechanical properties.

4- Overall, the synergistic effects of combining steel, PVA, and glass fibers in concrete mixes result in materials with superior mechanical properties. These enhanced properties include increased compressive and tensile strength, improved ductility, and enhanced

resistance to cracking and impact. Such improvements are crucial for the development of durable and resilient concrete structures capable of withstanding the challenges of modern construction environments.

5- mix 7 is the best mix increased the tensile strength by 409 % because adding three types of fibers.

6- compressive strength for all mixes almost equal.

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