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Effect of Aluminium Fiber on the Strength property of Concrete

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ABSTRACT
This experimental work is aimed at determining the influence of aluminium waste fiber on plain cement concrete. To achieve this aim, compressive strength test has been conducted. The compressive strength test has been conducted in Compression machine. The plain cement concrete with the ratio 1:1.5:3 at 0.55 water cement ratio has been utilized in this study. Aluminium waste has been used as additional material in concrete. The weight of aluminium has been taken from 0.5%, 1.5% and 1.5% by weight of cement of varying aspect ratios that are 2.5 (length=0.5 inch, width=5mm), 5 (length=1inch, width=5mm) and 7.5 (1.5 inch, 0.5mm). A total number of ten batches, each batch contained six cubes and were casted for evaluation of compressive strength test. The curing ages selected for this particular study have been 7 and 28 days. It has been observed in this study that aluminium waste has resulted into a decrease in compressive strength of concrete as compared to normal concrete. This study has made application of solid waste as addition material in concrete. Therefore, this study will be helpful to reduce environmental pollution.

Keywords
Aluminium waste fiber, Compressive Strength.

1. Introduction
A variety of building materials with a number of key ingredients are constructed out of concrete, which is usable and widely employed [1]. Concrete consists in primary components such as cement, water, aggregates consisting of sand, gravel etc., and additives or emulsifiers are frequently added to it. Concrete consumption in the global building and infrastructure development sector is an important aspect [2]. The majority of building projects, including structures, bridges, roads, dams, tunnels and so forth, are made up of concrete [3]. The continued demand for new infrastructures and housing, which is accompanied by increased concrete consumption, has been driven by an expanding world population and urbanization [4]. Housing, commercial and transport infrastructure will continue to be needed as urban areas expand. The construction of these projects relies significantly on concrete and, in turn, has a further impact on consumption [5]. In the case of renovation or maintenance projects, concrete is also a major use. In addition, older buildings often need to be repaired or updated and concrete is frequently used in order to increase structural integrity and extend the lifespan of buildings and infrastructure [6]. Concrete is increasingly used in warehouses, manufacturing facilities, and commercial premises due to its reliability and load-bearing capacity. Sustainable construction practices and innovation in production have led to increased consumption in developing economies [7]. Aluminium is naturally resistant to corrosion, and the inclusion of it in concrete can give rise to a material's durability which will contribute to reduced risk of damage caused by corrosion over time. Aluminium has the highest number of applications in the world. After steel with an annual consumption of 88 million tons. According to the North American Aluminium Industry Sustainable- Report published by the aluminium association, worldwide racy. For transportation, the cling of aluminium will increase up to 90%. Construction works, and around 70% for beverage cans. Overall, EU aluminium consumption is estimated at around 120 Mt and the quantity of old scrap as a whole reached approximately 2 million tonnes during 2004. Recycling aluminium waste to make concrete is an environmentally friendly practice that reduces landfilling and conserves natural resources. Nevertheless, in order to ensure compatibility with the specific requirements of construction projects, it is important to point out that while aluminium waste has its advantages, concrete inclusion should be carefully considered and optimized [8]. Aluminium offers sustainability, resource conservation, and economic benefits due to its easy recycling. It can be used in various sectors, including packaging, industrial scrap, and post-consumer waste. It can promote environmental protection, circular economy practices, and technological innovation [9]. Aluminium scrap is a low-cost raw material found in various forms like beverage vessels, food

packs, radiators, wire, and chipboards. It enhances concrete's characteristics like rigidity, impact resistance, and fatigue resistance. Fibres also provide reinforcement, compensating for brittleness. Aluminium is lighter and less corrosive than steel. According to IAI (International Aluminium Institute), there are approximately 17 million tonnes of aluminium scrap currently stockpiled around the world and it is estimated that this will grow to more than 21 million tonnes by 2020. Approximately 95% of aluminium produced by the automotive and building industry is recycled throughout Europe. Various factors such as global manufacturing, consumer consumption, recycled rate and economy have a bearing on the precise yearly quantity of aluminium waste produced worldwide. Nevertheless, according to a report published by International Aluminium Institute in January 2022, there were more than 60 million tonnes of aluminium produced annually worldwide and a large proportion was recycled [10].

2. Materials and Methodology

The study has been based upon determining the effect of aluminum fiber on the properties of concrete. Test of compressive strength t has been performed.

2.1 Materials

2.1.1 Cement

In this study Ordinary Portland cement (OPC) Lucky cement has been used as a binding material.It has been obtained from local market.

2.1.2 Fine aggregate

Fine aggregate is defined as material which passes through sieve #4 (4.75mm) and retained on sieve #200 (0.075mm). In this research work, sand obtained from local market of Khairpur has been used. It is bollari sand which is originally brought from Jamshoro. The Fine aggregates have to play an essential role as it fills the spaces which are still there after cement and coarse aggregate enclosure.

2.1.3 Coarse aggregate

Coarse aggregates may be defined as aggregates which retain from sieve #4 (4.75mm). The maximum coarse aggregates are used to provide strength to concrete mix. Therefore, these are vital part of high strength concrete. Furthermore, crushed and angular size coarse aggregate are the best suited for high strength concrete. The coarse aggregate having size 19mm has been collected from construction materials' market Khairpur.

2.1.4 Aluminium waste

In this research work, aluminum fiber of width 5mm having different lengths of 0.5 inch, 1 inch and 1.5 inch were used.

Fig:1 Shows aluminium fiber

2.1.5 Water

Potable water is used for mixing and making concrete.

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2.2 Research Methodology

Cubes of 150 x 150 x 150 mm size were used. The total number of 60 cubes consisting of 10 batches, while each batch consisted 6 cubes specimen, were casted throughout this research. Among 60 specimen of 10 batches, 6 specimen of 1 batch were made with controlled concrete (without inclusion of aluminium fiber) and remaining 54 specimen of 9 batches were made of fiber reinforced concrete (inclusion of aluminium fiber). All 6 specimen were made using 0.5 inch, 1 inch and 1.5 inch of aluminium fiber respectively. After casting the cubes were demoulded after 24hours and then kept in water tank for 7 and 28 days for proper curing. After proper 7 and 28 days curing, they were tested for compressive strength.

3 Testing of concrete

3.1 compressive strength

The most common hardened concrete test is compressive strength of concrete which is generally laboratory test, it is done by Compression machine and is easy to perform. The compressive strength provides the best and clear information that the concrete is how much capable to resist against crushing. In this test cubes of 150mm x 150mmx 150 mm were prepared and tested at 7 and 28 days of curing.

EQUIPMENTS

Compression testing machine.(CTM)

TEST PROCEDURE

The concrete batches have been carried out on ground surface manually and the materials were weight as per mix design, the ground surface was moistened with a wet cloth before the mixing. The aggregates placed and mixed thoroughly then cement was added and aluminium fibre together was also mixed as per proposed batch. All the concrete material were mixed with hand till the uniform mixing was achieved. Drinking water / tap water mixed slowly and then concrete about 05 to 08 minutes was mixed to get uniform mixing. At the event when concrete is properly mixed then poured in to moulds having shape of cubes 150mm x 150mm x 150mm in equal 3 layers and were placed on table vibrator for proper compaction. After 24 hours of casting the concrete moulds were removed and concrete specimen were placed in water for 7 and 28 days for curing purpose for every mixture four specimen were prepared. At 7 th and 28 th day the specimen were tested for compressive strength in the laboratory. The compressive strength test has been performed as per BS 1881 [11].

4. Results and discussion

4.1 Compressive strength

The compressive strength is the ability of materials to resist compressive stresses. This test has been performed in Compression machine. The curing ages selected have been 7 days and 28 days. The percentage addition of aluminium set for this experimental study are 0.5%, 1% and 1.5% by weight of cement.

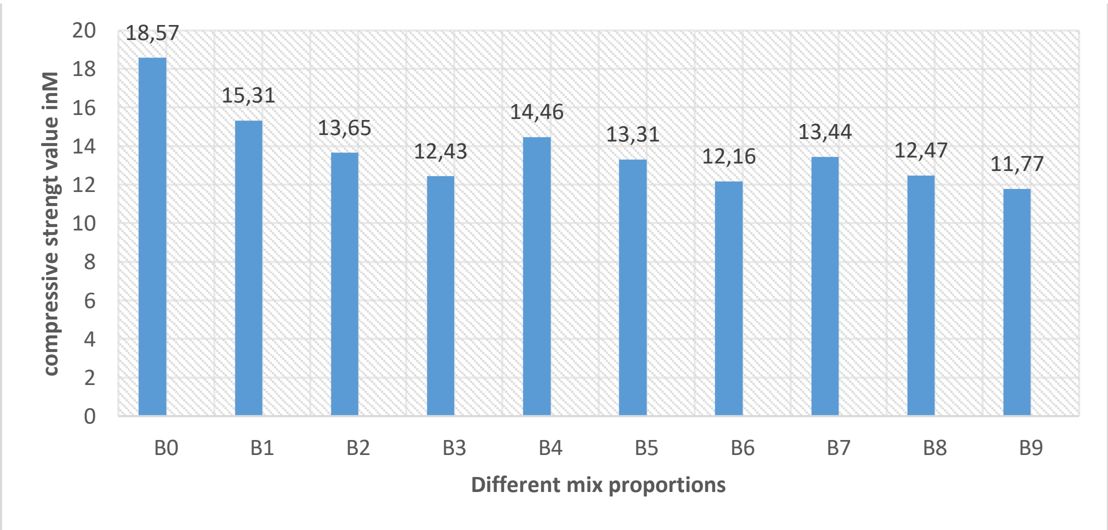

Fig. 2. The compressive strength of different concrete batches containing aluminium fiber at 7 days

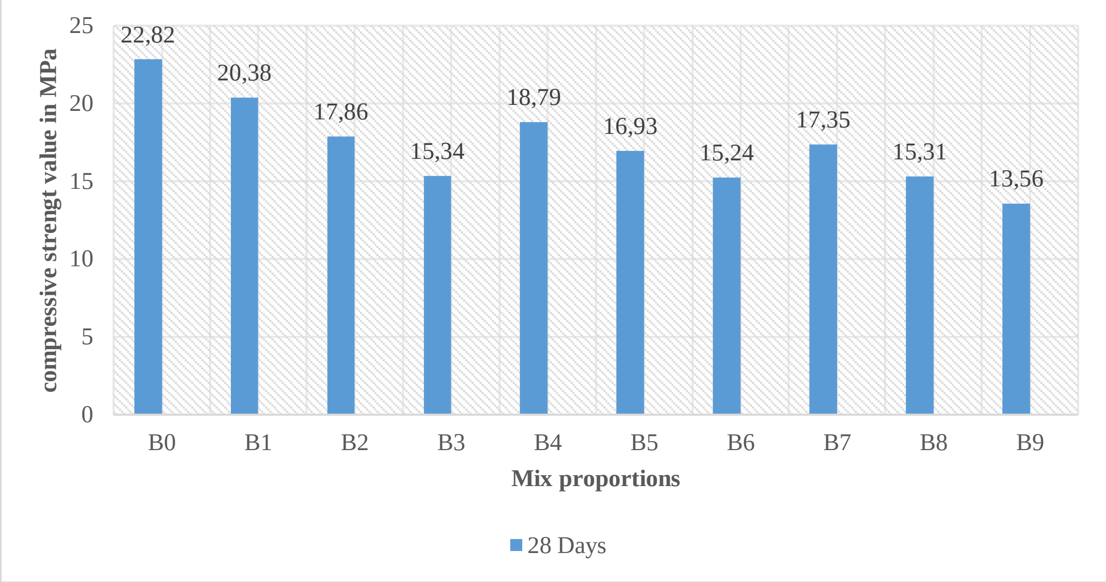

Fig. 3. The compressive strength of different concrete batches containing aluminium fiber at 28 days

Fig.2 and figure 3 suggest that the compressive strength of concrete containing aluminium fiber has decreased with respect to that of normal concrete on 7 and 28 days curing. The maximum decrease in compressive strength has been observed in B9.This is because Tri calcium aluminate Calcium sulfoaluminate (3CaO.Al2O3.3CaSO4·31H2O) is created when tricalcium aluminate and gypsum (CaSO4) react. This prevents the mixture from strengthening immediately, and on the other hand, aluminum waste combines with alkali to release hydrogen gas. As a consequence, hydrated aluminum and hydrogen gas disrupt the chemical reaction between C3A and CaSO4 which initiates expansion and cracking and leads to the development of strength reduction.

5. Conclusion and suggestion

The main points drawn as the conclusion are mentioned below:

1. The compressive strength has shown a declining pattern with the increase in the dosage of aluminium waste fiber in concrete.

2. On 7 days curing, the percentage decrease in compressive strength of 0.5”(0.5%), 0.5”(1%), 0.5”(1.5%), 1”(0.5%), 1”(1%), 1”(1.5%), 1.5”(0.5%), 1.5”(1%) and 1.5”(1.5%) are 17.55%, 26.49%, 33.06%, 22.13%, 28.32%, 34.51%, 27.62%, 32.84% and 36.62% respectively with respect to normal concrete.

3. On 28 days curing, the percentage decrease in compressive strength of 0.5”(0.5%), 0.5”(1%), 0.5”(1.5%), 1”(0.5%), 1”(1%), 1”(1.5%), 1.5”(0.5%), 1.5”(1%) and 1.5”(1.5%) are 10.69%, 21.73%, 32.77%, 17.65%. 25.81%, 33.21%, 23.97%. 32.91% and 40.57% respectively with respect to normal concrete.

4. Above results led to draw conclusion that the effect of aluminium waste fiber has been negative in the case of compressive strength.

This study recommended that the future studies may consider the different sizes of aluminium fiber with different percentages.The curing period may be considered more than the 28 days and the different w/c ratio may be considered in the future studies.

6. Acknowledgement

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