CONCRETE PERFORMANCE CONTAINING MINERAL ADMIXTURE

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ABSTRACT

This paper reports on an experimental program to investigate the effect of using the steel – fiber waste as a replacement of coarse aggregate on the workability and compressive strength of concrete. The steel – fiber waste is the waste collected from the turner shops, it's considered as a waste which could have a promising future in construction industry. For this research work, slump and compressive test were conducted for various proportions of steel –fiber waste as a replacement of aggregate in concrete. The obtained rustle were compared with those of the control concrete (0% steel –fiber waste). The result shows an increase in the compressive strength of the concrete by adding steel fiber until an optimum range of 10%. However the slump test results showed that the workability of concrete decreases with adding steel fiber waste.

TABLE OF CONTENTS

ABSTRACT i
TABLE OF CONTENTS ii
CHAPTER 1 INTRODUCTION 1
1.1. Introduction 1
1.2. Requirements for Good Concrete 1
1.2.1. Strength 1
1.2.2. Water Tightness 2
1.3. Admixtures 2
1.3.1. Types of Admixtures 2
1.3.2. Chemical Admixtures 2
1.3.3. Mineral Admixtures 3
1.4. Problem Statement 3
1.5. Objective 3
CHAPTER 2 LITERATURE REVIEW 4
2.1. Introduction 4
2.2. Background on Concrete 4
2.3. The Role of Concrete Industry 4
2.4. Previous Studies 5
CHAPTER 3 METHODOLOGY 8
3.1. Introduction 8
3.2. Experimental Study 8
3.3. Mix Design 9
3.4. Materials 10
3.4.1. Cement 10
3.4.2. Aggregates 10
3.4.3. Steel Fiber Waste 10
3.4.4. Water Content 11
3.4.5. Sand 11
3.5. Experimental Procedure 11
3.6. Calculation of Compressive Strength 11
3.7. Slump Test 12
3.8. Compression Test 13

CHAPTER 4 RESULT AND DISCUSSION 14
4.1. Introduction 14
4.2. Data from Compressive Test 14
4.3. Data from Slump Test 15
4.4. Results and Discussion 17
CHAPTER 5 CONCLUSION AND FUTURE RECOMMENDATION 21
5.1. Conclusion 21
5.2. Recommendations for Further Studies 21
APPENDICES 22
Preparation of Samples 22
Slump Test 23
Compression Test 24
REFERENCES 25

TABLE OF FIGURES

Figure 2. 1. Bottle caps as fibers 6
Figure 2. 2. Percentage of bottle cap fiber vs compressive strength 7

Figure 3. 1. Flow Chart of Experimental Program 8
Figure 3. 2. Slump test 12
Figure 3. 3. Compression test 13

Figure 4. 1. Compressive Strength for 7 days 17
Figure 4. 2. Compressive Strength for 7 days 18
Figure 4. 3. Different sizes of steel fiber 18
Figure 4. 4. Compressive Strength for 28 days 19
Figure 4. 5. Compressive Strength for 28 days 19
Figure 4. 6. Slump test 20
Figure 4. 7. Slump test 20

Appendices

Figure 1. Mixing of the concrete ingredients 22
Figure 2. Compaction of the concrete in the cubes 22
Figure 3. Concrete cubes before hydration 23
Figure 4. Slump test 23
Figure 5. Compression test 24

LIST OF TABLES

Table 3. 1. Mix Design 9

Table 4. 1. Mix proportions and compressive strength of concrete with mineral admixture 14
Table 4. 2. Mix proportions and compressive strength of concrete with mineral admixture 15
Table 4. 3. Mix proportions and slump test of concrete with mineral admixture 16
Table 4. 4. Mix proportions and slump test of concrete with mineral admixture 16

CHAPTER I
INTRODUCTION

1.1. Introduction

The global demand for raw materials has surged due to rapid industrialization and high consumption, leading to volatile costs and competition. Iron ore, essential for steel production, is heavily utilized, with 98% of mined ore going towards steelmaking. Industrialization and population growth have increased waste production, prompting strategies to reduce and recycle waste. The construction industry, facing shortages of natural aggregates, is exploring sustainable alternatives. Steel fiber, a byproduct of metal manufacturing, shows promise as a substitute for traditional aggregates in concrete. This fiber can enhance concrete's strength and durability, transforming its typically brittle nature by improving toughness and post-cracking behavior.

1.2. Requirements for Good Concrete

Good concrete requires high-quality cement, sand, coarse aggregate, and water, all carefully measured. The best-graded and cleanest aggregate produces the strongest concrete. Proper workability is crucial to fill form spaces without defects. Improper handling can lead to poor, non-uniform concrete. Proper curing is essential to prevent moisture loss during setting. Strength, durability, and water-tightness of concrete depend on the water-cement ratio.

1.2.1. Strength

The compression strength of concrete is very high, but its tensile strength (meaning its ability to resist stretching, bending, or twisting) is relatively low. Consequently, concrete that must resist a good deal of stretching, bending, or twisting, such as concrete in beams, girders, walls, columns, and the like, must be reinforced with steel. Concrete that must resist compression only may not require reinforcement.

1.2.2. Water Tightness

The ideal concrete mix uses just enough water for cement hydration but would be too stiff to pour. Extra water is needed for pourability, but it creates voids when it evaporates, reducing water tightness. These voids form interconnected channels during hardening. To keep concrete watertight, use the minimum water necessary for workability.

1.3. Admixtures

Instead of special cement, additives or admixtures can modify properties of common cements. While additives are added during cement manufacturing, admixtures are added during mixing. Many products are available, but performance tests are advisable to ensure desired effects and avoid unknown issues.

1.3.1. Types of Admixtures

Concrete admixtures are used to improve the behavior of concrete under a variety of conditions and are of two main types: Chemical and Mineral.

1.3.2. Chemical Admixtures

Chemical admixtures reduce the cost of construction, modify properties of hardened concrete, ensure quality of concrete during mixing/transporting/placing/curing, and overcome certain emergencies during concrete operations.

Chemical admixtures are used to improve the quality of concrete during mixing, transporting, placement and curing. They fall into the following categories:

- air entrainers
- water reducers
- set retarders
- set accelerators
- superplasticizersSpecialty admixtures: which include corrosion inhibitors, shrinkage control, alkali-silica reactivity inhibitors, and coloring.

1.3.3. Mineral Admixtures

Mineral admixtures make concrete more economical, reduce permeability, and increase strength. They influence hardened concrete through hydraulic or pozzolanic activity, with pozzolans including natural materials like volcanic ash, fly ash, and silica fume. Adding fibers increases large pores in the cement paste, affecting its bleeding behavior. Depending on the type and amount, fibers can reduce plastic shrinkage cracks by 30 to 40% when used at 0.1% by volume.

1.4. Problem Statement

Research on the effects of steel fiber in concrete is lacking in our region, necessitating studies to determine its properties and benefits. This research will guide future studies on the mechanical properties of reinforced concrete. Currently, steel fiber waste from turner shops is dumped, increasing environmental pressure due to the lack of proper landfills. The concrete industry must contribute to sustainable development by reducing cement content and recycling materials. This project aims to recycle steel fiber waste as an aggregate replacement in concrete, reducing industry waste. Uniformly distributing steel fibers in concrete is crucial to avoid strength-reducing conglomerates. During transport, fibers often interlock, forming hard-to-break masses. To prevent this, fibers must be manually or mechanically unraveled before mixing. Manual unraveling is time-consuming and inefficient for large amounts. Adequate unpacking and unraveling equipment is needed to match the capacity of concrete mixing plants, ensuring efficient and high-quality production.

1.5. Objective

1. To utilize steel fiber waste as a replacement aggregate in concrete development.

2. To determine the compressive strength of concrete by using mineral admixture and do slump test of the mix design.

3. To reuse steel waste obtained from turner shops as a construction material in plain concrete.

4. To improve concrete properties by using mineral admixture (Steel Fiber)

5. To use recyclable materials helps to reduce the depletion of our natural resource.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

This chapter reviews the impact of steel fiber on concrete properties and highlights successful uses of alternative materials, particularly recycled steel fibers from turner shops as coarse aggregate. It examines literature on chemical and mineral admixtures in concrete. A comparison is made between conventional concrete and steel-fiber reinforced concrete based on basic engineering properties.

2.2. Background on Concrete

The invention of concrete depends on the interpretation of "concrete." Ancient cements were made by crushing and burning gypsum or limestone. When mixed with sand and water, these cements formed mortar, a plaster-like material for adhering stones. Over time, these materials evolved into modern concrete.

Today's concrete uses Portland cement, stone and sand aggregates, and water. Admixtures control setting properties, especially in extreme conditions. Early composite materials included mortar for stone building, unlike modern concrete, which is cast in molds. Concrete ingredients, including cement, have changed and continue to evolve based on the forces they need to resist, such as gravity, soil heaving, lateral loads, erosion, abrasion, or chemical attack. The mix design specifies the ingredients and their proportions.

2.3. The Role of Concrete Industry

The concrete industry must improve its record as it is a major contributor to air pollution and consumes vast quantities of natural materials. For each ton of cement produced, one ton of CO_2 is released. In 1995, the cement industry produced 1.4 billion tons, emitting as much CO_2 as 300 million cars, accounting for almost 7% of global CO_2 emissions. As the most widely used material worldwide, the industry has a duty to contribute to sustainable development.

Declaring concrete "green" is not enough; concrete production must take steps toward sustainability. Reducing Portland cement content is essential due to its high energy consumption and greenhouse gas emissions. Researchers developing low-energy cementitious materials or using industrial waste products contribute significantly to this goal. Another approach is substituting recycled materials for aggregate or reinforcement, including recycling concrete itself. The concrete industry consumes 8 billion tons of natural material annually, so reducing reliance on virgin materials is crucial. Recent advances in these areas will guide future research for more environmentally friendly concrete. Increasing durability through better mix designs, and appropriate aggregates and admixtures can also conserve natural resources by reducing the need for frequent replacements.

2.4. Previous Studies

Previous experiments have demonstrated the impact of chemical and mineral admixtures on concrete performance. The compressive strength of concrete is influenced by aggregate properties and cement paste characteristics, and is affected by mix proportions, water/cement ratio, compaction, and curing. Porosity is a key factor in concrete strength, as noted by Mindess (1981).

The bond developed during hardening is both physical and chemical. Reactive elements in aggregates can enhance this bond, as suggested by Ryan (1992). However, using recycled aggregate can sometimes reduce compressive strength. Durability is crucial and can be enhanced by selecting low w/c ratios, proper compaction, and curing methods. Pozzolans like fly ash, GGBF slag, and silica fume reduce permeability and improve durability.

Compaction and curing are essential for durable concrete, preventing trapped air and promoting hydration. Aggregates can also impact durability through alkali-silica reactions, which cause expansion and cracking. Indirect tests such as permeability and absorption tests assess concrete durability, but simpler methods are needed for quick assessment.

Nagataki (2001) compared chemical and mineral admixtures, highlighting their benefits and applications. Silica fume, used in conjunction with superplasticizers, improves concrete strength and durability. However, its effectiveness against frost damage varies by region.

Manjrekar and Rathi (2006) found that superplasticizers enhance cement dispersion and hydration, reducing water requirements and porosity. Chavan et al. (2013) demonstrated that copper slag as a fine aggregate replacement increases compressive strength. Behera and Behera (2015) tested concrete with bottle cap fibers, finding improved strength with fiber inclusion.

Recycling and reusing materials like steel fibers from turner shops can reduce waste and improve concrete properties. This project aims to explore these possibilities, contributing to sustainable development in the concrete industry.

Figure 2. 1. Bottle caps as fibers

After compression testing the cubes, they found that Compressive strength increases with increase in percentage of bottle cap fibers. The increase is not prominent up to 1.0 % as the increase is only 1.93 % for addition of 1.0 % fiber. The chart below shows the variation of compressive strength with percentage of fiber:

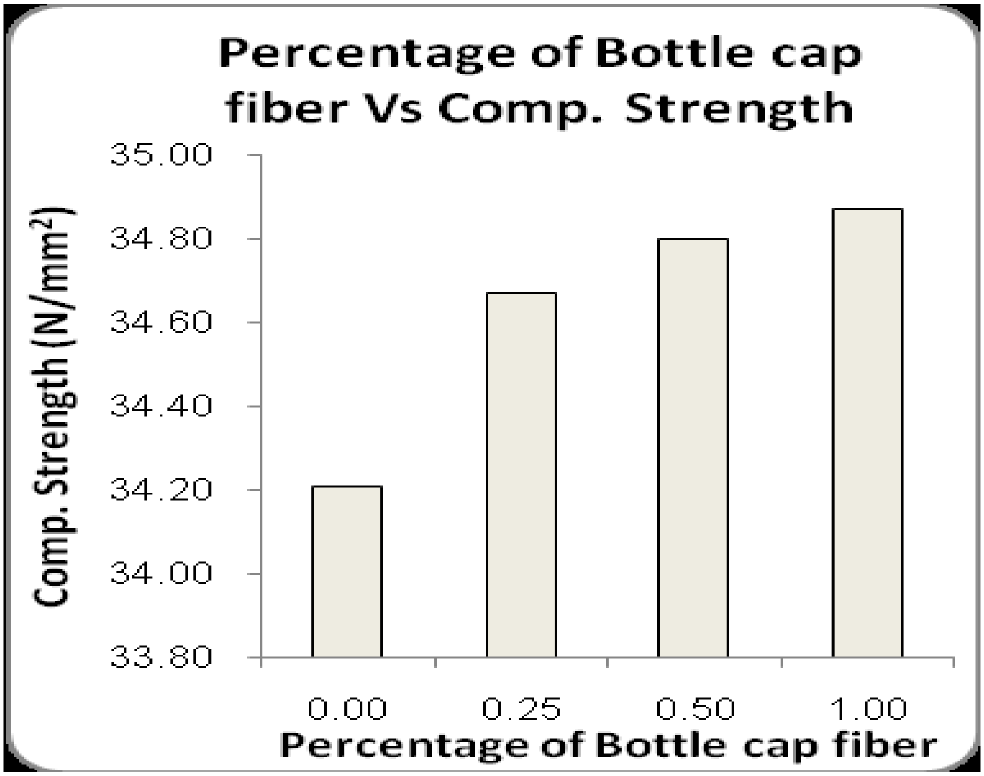

Figure 2. 2. Percentage of bottle cap fiber vs compressive strength

Bentezl, Peltzl, and Winpigler (2009), established that the influence of waterto-cement mass ratio (w/c) on early-age properties of cement-based materials is investigated using a variety of experimental techniques. Properties that are critical to the early-age performance of these materials are tested, including heat release, semiadiabatic temperature, setting time, autogenously deformation, and strength development. Measurements of these properties using a single cement are presented for four different w/c, ranging from 0.325 to 0.425. Some of the measured properties are observed to vary widely within this range of w/c ratios. The heat release and setting time behaviors of cement pastes are contrasted. While early-age heat release is relatively independent of w/c, the measured setting times vary by several hours between the four w/c investigated in this study, indicating the fundamental differences between a physical process such as setting and heat release which is purely a quantification of chemical reaction. While decreasing w/c certainly increases compressive strength at equivalent ages, it also significantly increases autogenously shrinkage and may increase semi-adiabatic temperature rise, both of which can increase the propensity for early-age cracking in cement-based materials.

CHAPTER 3

METHODOLOGY

3.1. Introduction

The purpose of this work is to study the impact of and determine the effects of steel fiber waste on the workability, durability and compressive strength of concrete as well as to determine the optimum mix proportions. Recently, a lot of studies have been conducted to indicate the effect of chemical and mineral admixtures in normal concrete but using waste in concrete mixture as aggregate replacement to enhance the properties of concrete can be considered as a new and innovative method in concrete technology.

3.2. Experimental Study

In order to achieve the stated objectives, this study was carried out in few stages. On the initial stage, all the materials and equipment needed must be gathered or checked for availability. Then, the concrete mixes according to the predefined proportions. Concrete samples were tested through concrete tests such as cube test. Finally, the results obtained were analyzed to draw out conclusion.

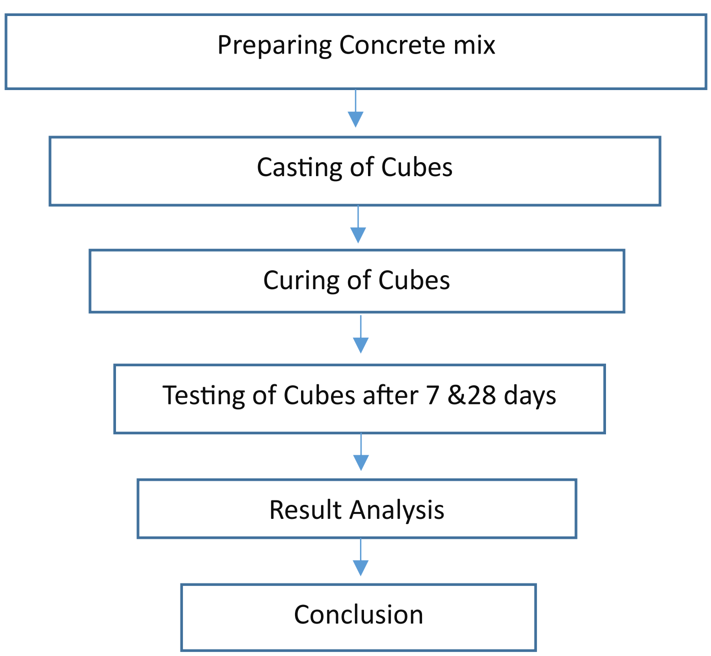

Figure 3. 1. Flow Chart of Experimental Program

3.3. Mix Design

The objective of this project is to study the impact of using steel fiber waste as aggregate replacement in concrete mixture by performing slump test and compression test. This project utilized steel fiber as the substitute of aggregate to replace the common aggregate, its suitability to function as aggregate and its contribution to concrete strength will be evaluated. The mix design calculation is done according to the ACI codes. The number of mix designs is 13 mix designs. Four concrete cubes are prepared for each mix design; consequently 52 cubes of concrete are tested (8 control cubes and 44 steel fiber reinforced cubes). These trial mixes are varied in water cement ratios and the percentages of steel fiber waste in the aggregate added to the concrete mix. The steel fiber waste chosen for this project was collected from the turner shops in the industrial region in Sulaimanyiah (Nawchay Pishasazy). The steel fiber waste has ability to dramatically increase the workability of the fresh concrete mix. The recommend dosages for the steel fiber was a range of 3 to 15 percent as a replacement of aggregate for conventional concrete mixes, the mix design is shown in the table below.

Table 3. 1. Mix Design

S.N	W/C	Cement	Steel fiber	Sand	Aggregate	Water
A	0.42	7.6	(0%) 0	14.2	25.66	3.2
B	0.42	7.6	(3%)0.75	14.2	24.9	3.2
C	0.42	7.6	(5%)1.285	14.2	24.4	3.2
D	0.42	7.6	(7%)1.79	14.2	24	3.2
E	0.42	7.6	(10%)2.56	14.2	23	3.2
F	0.40	8	(0%)0	13.2	23.36	3.2
G	0.40	8	(3%)0.7	13.2	22.7	3.2
H	0.40	8	(5%)1.16	13.2	22.2	3.2
I	0.40	8	(7%)1.63	13.2	21.7	3.2
J	0.40	8	(10%)2.3	13.2	21.0	3.2
K	0.40	8	(12%)2.8	13.2	20.5	3.2
L	0.40	8	(14%)3.2	13.2	20.1	3.2
M	0.40	8	(15%)3.5	13.2	19.8	3.2

3.4. Materials

3.4.1. Cement

Cement is a fine, soft, powdery-type substance. It is made from a mixture of elements that are found in natural materials such as limestone, clay, sand and/or shale. When cement is mixed with water, it can bind sand and gravel into a hard, solid mass called concrete. Cement is usually gray. White cement can also be found but it is usually more expensive than gray cement.

3.4.2. Aggregates

Aggregate quality is crucial in concrete as it occupies about three-quarters of its volume. It not only affects concrete strength but also its durability and structural performance. Initially viewed as mere fillers, aggregates now significantly impact both plastic and hardened concrete properties. With aggregates constituting up to 80% of the mix, their quality is paramount.

Aggregates are broadly categorized into heavy weight, normal weight, light weight, and ultra-light weight. However, in most concrete practices, only normal weight and light weight aggregates are used. Heavy weight aggregates are utilized for specialist purposes like nuclear radiation shielding, while light weight aggregates are employed for thermal insulation in concrete.

3.4.3. Steel Fiber Waste

The main role of the fibers into the concrete matrix is to increase the durability of normal concrete. Using steel fiber waste in concrete provides significant economic benefits for the final cost of concrete because it would decrease the amount of coarse aggregate being used. In addition another role is to bridge the cracks that develop in concrete element when subjected to different kind of actions. Steel fibres used for reinforcing concrete are characterized by mechanical properties and geometrical parameters including the length and the correspondent aspect ratio and the shape.

The composition of steel fibres generally includes carbon steel (or low carbon steel, sometimes with alloying constituents), or stainless steel.

The most important mechanical properties of the fibres in reinforcing concrete are the fibre strength and stiffness as well as theirs ability to bond with the concrete matrix. Bond is mainly dependent on the aspect ratio of the fibre being sent to the grinding step, the steel fiber should be cleaned to eliminate any rubbish inside it.

3.4.4. Water Content

Water quality is crucial for concrete, as impurities can affect cement settling, concrete strength, and surface staining, and may lead to reinforcement corrosion. Potable water is generally safe for concrete, but non-potable water can also be used if it lacks a saline taste and falls within a pH range of 6 to 8, regardless of color or odor. Slightly acidic natural waters are harmless, but those containing organic acids or highly alkaline substances should be tested before use in concrete.

3.4.5. Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type.

3.5. Experimental Procedure

Concrete ingredients were weighed using an electrical balance and mixed manually for each mix design. Slump tests were conducted using a slump cone filled in three layers and compacted with a tamping rod, measuring the subsidence as the slump. Test cubes were cast according to BS EN 12390-1: 2000 in steel or cast iron molds, compacted with 35 strokes per layer. Cubes were cured under specified conditions until the testing age as per BS EN 12390-2: 2000, typically at 7 or 28 days. Compression tests, as per BS EN 12390-3: 2002, were conducted with cubes placed between platens and loaded at a constant rate of stress. Testing machines apply lateral forces, inducing shear and causing typical failure modes such as near-vertical cracks or explosive failure in less rigid machines.

3.6. Calculation of Compressive Strength

Compressive strength is calculate using the following formula

Compressive strength (kg/cm2) = Wf / Ap

Where

Wf = Maximum applied load just before load, (kg)

Ap = Plan area of cube mould, (mm2)

3.7. Slump Test

In construction and civil engineering, the concrete slump test (also known as the slump test) is an in on site or a laboratory test employed to ascertain and estimate the difficulty and consistency of a given sample of concrete prior to curing. Precisely, the concrete slump test is a quality control approach. However, for a specific mix, the slump should be constant. A modification in slump height would express an unsought alteration in the ratio of the concrete ingredients; the proportions of the ingredients are then modified to maintain the consistency of a concrete batch. This homogeneity enhances the quality and structural integrity of the cured concrete. This test is performed to check the consistency of freshly made concrete. The slump test is done to make sure a concrete mix is workable. The measured slump must be within a set range, or tolerance, from the target slump.

Workability of concrete is mainly affected by consistency i.e. wetter mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. It can also be defined as the relative plasticity of freshly mixed concrete as indicative of its workability.

Figure 3. 2. Slump test

3.8. Compression Test

Compression test assesses concrete's compressive strength, widely used in construction. Two common specimen types, cubes and cylinders, are used for testing. It determines the concrete's maximum strength under ideal conditions. Testing should be meticulous as inaccurate results can be costly. Laboratory testing is standard, with concrete cylinders made on-site. Strength is measured in Megapascals (MPa), typically at 28 days after mixing.

Figure 3. 3. Compression test

CHAPTER 4

RESULTS AND DISCUSSION

4.1. Introduction

The chapter presents data and results from experimental testing, focusing on compressive and slump tests. Slump test evaluates workability or consistency of concrete mixes, especially fiber-reinforced concrete. Fibers hinder coarse aggregate movement, reducing material flow; larger aggregates or fiber aspect ratios decrease flowability. Increasing mortar content or initial slump can enhance workability, especially for stiff concretes consolidated by intense vibration. Compressive strength test assesses various concrete characteristics and quality of concreting. It determines a material's ability to withstand loads compressing it, unlike tensile strength, which resists stretching. In materials science, tensile, compressive, and shear strengths are analyzed separately.

4.2. Data from Compressive Test

The data and obtained results from the compressive test can be shown obviously in the first section of this chapter. Different mixes of concrete with different proportions of each material are demonstrated in table 1. The concrete mixes shown in table 1 have a water cement ratio of 0.42 and the aggregate of each mix is replaced by different percentages of steel fiber. And 14.2 kg of sand is used in each mix. And the results obtained from the compressive test for 7 days and 28 days are indicated.

Table 4. 1. Mix proportions and compressive strength of concrete with mineral admixture

S.N.	W/C	Cement	Steel Fiber (S.F)	Sand	Aggregate	Water	7 days strength (Mpa)	28 days strength (Mpa)
A	0.42	7.6	(%0) 0	14.2	25.66	3.2	18	27
B	0.42	7.6	(%3) 0.76	14.2	24.9	3.2	30	39.1
C	0.42	7.6	(%5) 1.285	14.2	24.4	3.2	21	28.1
D	0.42	7.6	(%7) 1.79	14.2	24	3.2	25	32.5
E	0.42	7.6	(%10) 2.56	14.2	23	3.2	26	32.9

The table above shows different mixes of concrete with different proportions of each material which have a water cement-ratio of 0.40 and the aggregate of each mix is replaced by higher percentages of steel fiber. And 13.2 kg of sand is used in each mix. And the results obtained from the compressive test for 7 days and 28 days are indicated as well.

Table 4. 2. Mix proportions and compressive strength of concrete with mineral admixture

S.N.	W/C	Cement	Steel Fiber (S.F)	Sand	Aggregate	Water	7 days strength (Mpa	28 days strength (Mpa)
F	0.40	8	(%0)0	13.2	23.36	3.2	25	30
G	0.40	8	(%3) 0.7	13.2	22.7	3.2	25	32.3
H	0.40	8	(%5) 1.16	13.2	22.2	3.2	25	32.5
I	0.40	8	(%7) 1.63	13.2	21.7	3.2	27	32.7
J	0.40	8	(%10) 2.3	13.2	21.0	3.2	25	31.5
K	0.40	8	(%12) 2.8	13.2	20.5	3.2	21	29.6
L	0.40	8	(%14) 3.2	13.2	20.1	3.2	23	29.4
M	0.40	8	(%15) 3.5	13.2	19.8	3.2	23	28.2

4.3. Data from Slump Test

Table 3 shows the results that were obtained from the slump test that have a water-cement ratio of 0.42.

Table 4. 3. Mix proportions and slump test of concrete with mineral admixture

S.N.	W/C	Cement	Steel Fiber (S.F)	Sand	Aggregate	Water	Slump test
A	0.42	7.6	(%0) 0	14.2	25.66	3.2	4.2 cm
B	0.42	7.6	(%3) 0.76	14.2	24.9	3.2	2.3cm
C	0.42	7.6	(%5) 1.285	14.2	24.4	3.2	2cm
D	0.42	7.6	(%7) 1.79	14.2	24	3.2	1.5cm
E	0.42	7.6	(%10) 2.56	14.2	23	3.2	1.5cm

Table 4 shows the results that were obtained from the slump test that have a water-cement ratio of 0.40. The slump values from the tables show that the type of the slump is true slump which is the only slump that can be measured in the test. The measurement is taken between the top of the cone and the top of the concrete after the cone has been removed.

Table 4. 4. Mix proportions and slump test of concrete with mineral admixture

S.N.	W/C	Cement	Steel Fiber (S.F)	Sand	Aggregate	Water	Slump test
F	0.40	8	(%0)0	13.2	23.36	3.2	4.5 cm
G	0.40	8	(%3) 0.7	13.2	22.7	3.2	4cm
H	0.40	8	(%5) 1.16	13.2	22.2	3.2	4 cm
I	0.40	8	(%7) 1.63	13.2	21.7	3.2	1.5 cm
J	0.40	8	(%10) 2.3	13.2	21.0	3.2	1.5cm
K	0.40	8	(%12) 2.8	13.2	20.5	3.2	3.3 cm
L	0.40	8	(%14) 3.2	13.2	20.1	3.2	2.5cm
M	0.40	8	(%15) 3.5	13.2	19.8	3.2	2 cm

4.4. Results and Discussion

The different test results from the experiments that were conducted in laboratories are shown in the figures below. The figures show the results of both slump test and compression test for 7 and 28 days separately. Figure 1 shows the compressive test results for 7 days of curing in water for a water-cement ratio of 0.42. From the test results, it can be seen that the compressive strength of steel fiber concrete mixes with 0%, 3%, 5%, 7%, and 10% coarse aggregate replacement with steel fiber, were higher than the control mix at all ages. But mix design B (denoted by mix design 2) in the figure has the highest compressive strength which indicates that there has been some errors in the experiment. The errors occurred due to the load applied to the concrete while compacting the concrete.

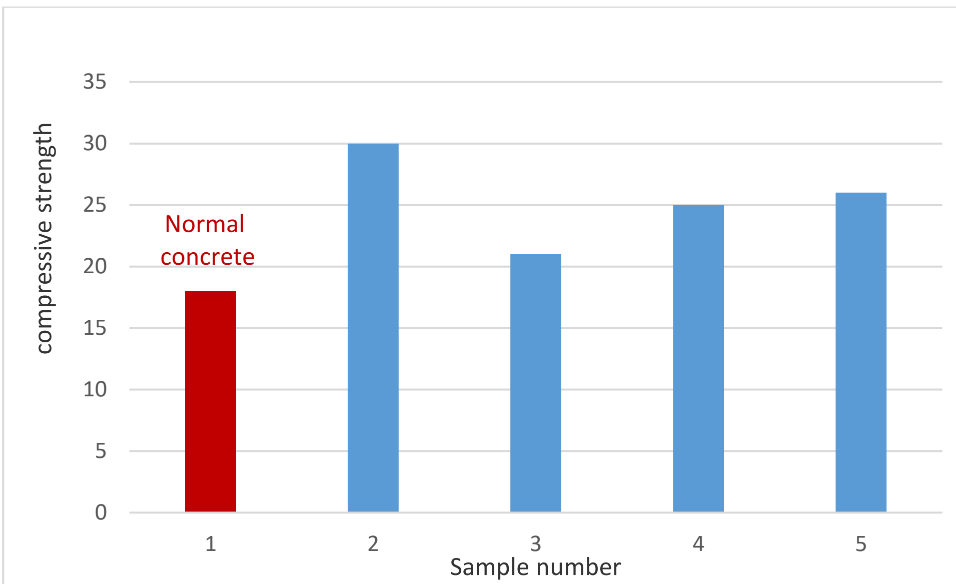

Figure 4. 1. Compressive Strength for 7 days

The figure below shows the compressive test results for 7 days of curing in water for a water-cement ratio of 0.40. From the test results, it can be seen that the compressive strength of steel fiber concrete mixes with 0%, 3%, 5%, 7%,10%, 12%, 14% and 15% coarse aggregate replacement with steel fiber, were higher than the control mix. Replacement of aggregate by steel fiber in the normal concrete improved of compressive strength up to 10% replacement and after that the strength were reduced for the 7 days. This may be due to the fact that the decrease of strength is due to the curing practices and temperature of the place that the concrete cubes were placed.

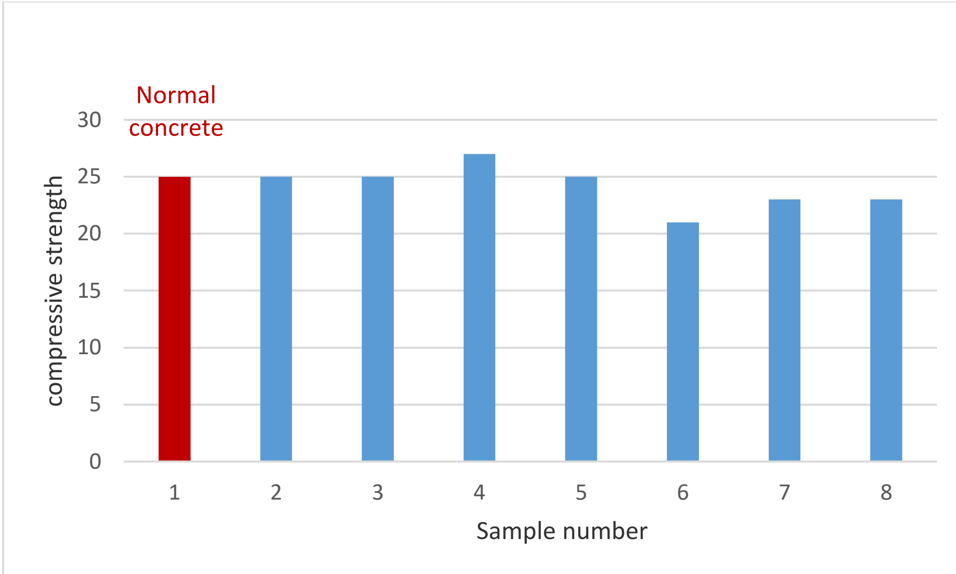

Figure 4. 2. Compressive Strength for 7 days

Other errors leading to this decrease in the compressive strength includes and size and the shape of the steel fiber used since the steel fibers used were obtained from different turner shop which can be obviously seen from the figures below. This issue can be solved by grinding the steel fibers to the same size with a special grinding machine or changing it to a powder form.

Figure 4. 3. Different sizes of steel fiber

At 28 days, compressive strength increases gradually with steel fiber addition at a water-cement ratio of 0.42. The 28-day results are more commonly used for acceptance purposes compared to 7-day results. Mix design B (designated as mix design 2) shows the highest strength, suggesting experimental errors. Errors likely stem from concrete compaction, curing, and temperature variations during testing.

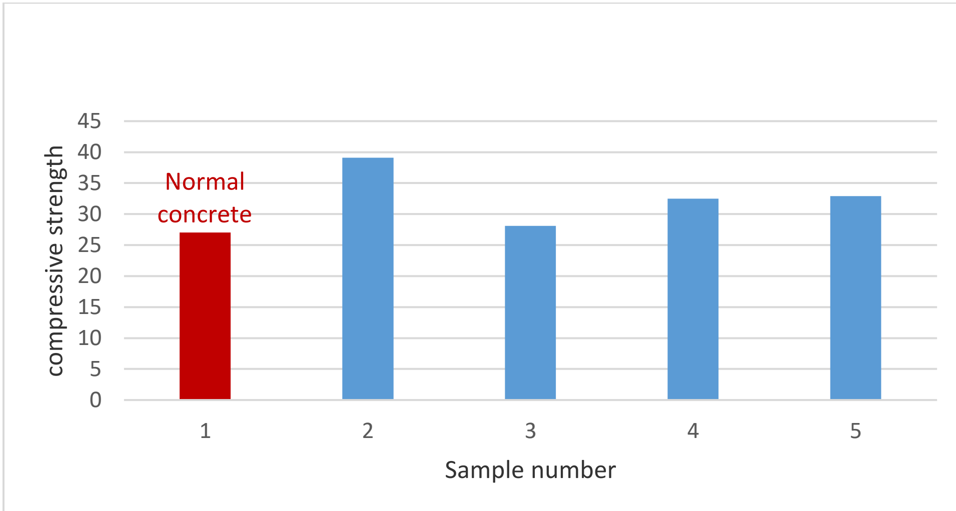

Figure 4. 4. Compressive Strength for 28 days

At 28 days, concrete with a water-cement ratio of 0.40 exhibits higher compressive strength compared to 7 days. Strength increases slightly with age, showing higher values with steel fiber addition. Optimal replacement of aggregate with steel fiber appears to be at 10%. Decrease in strength is attributed to curing practices, temperature variations, and variations in steel fiber size and shape. Grinding steel fibers to uniform size or converting them to powder form can resolve size discrepancies.

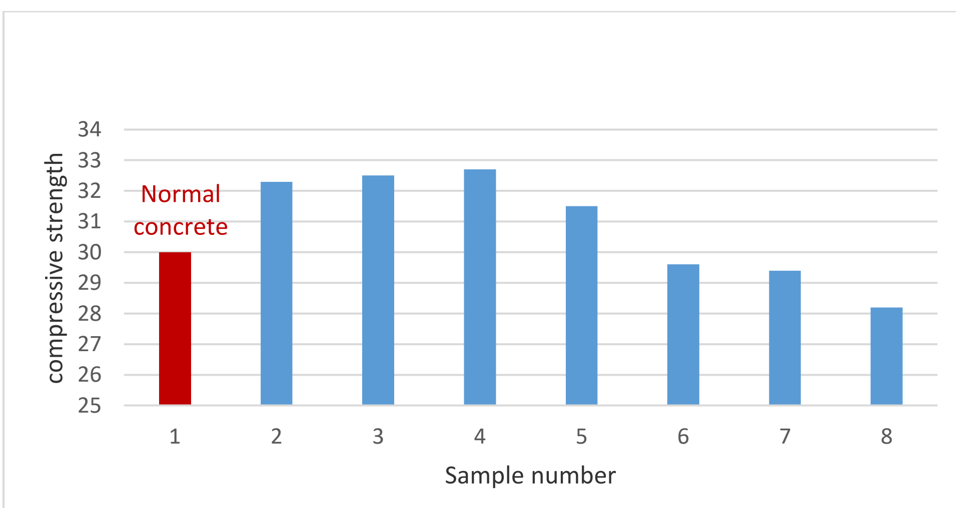

Figure 4. 5. Compressive Strength for 28 days

As steel fiber content increases, slump flow diameter decreases due to increased resistance to flow. The interlocking and friction between fibers and aggregates contribute to decreased flowability. Slump values range between 1.5 and 4.2 cm, indicating decreased workability with higher steel fiber content. Higher water-cement ratio (more water) and less aggregate result in more workable but less durable concrete. Mixes with lower water-cement ratio gain strength more rapidly. Errors in the slump test include variations in material properties, aggregate characteristics, air content, batching, mixing, and concrete temperature.

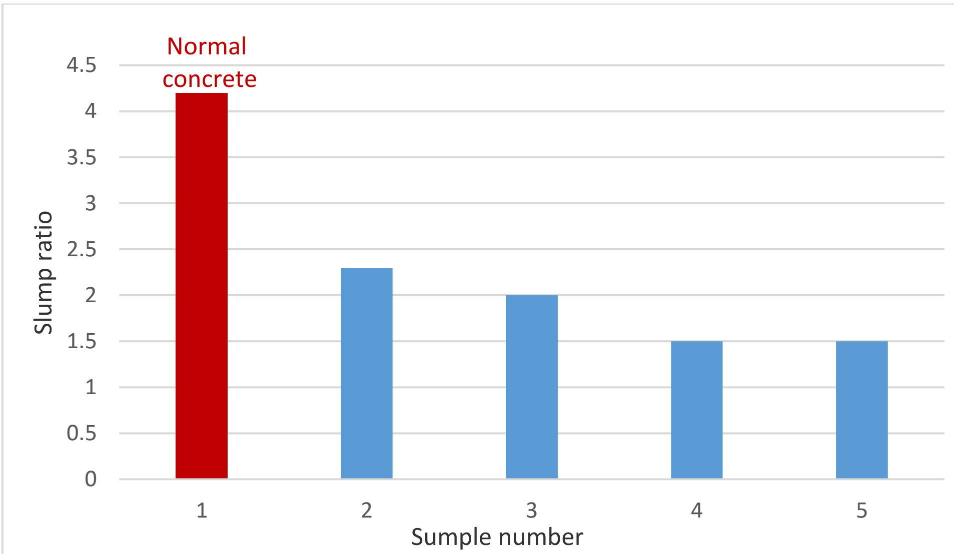

Figure 4. 6. Slump test

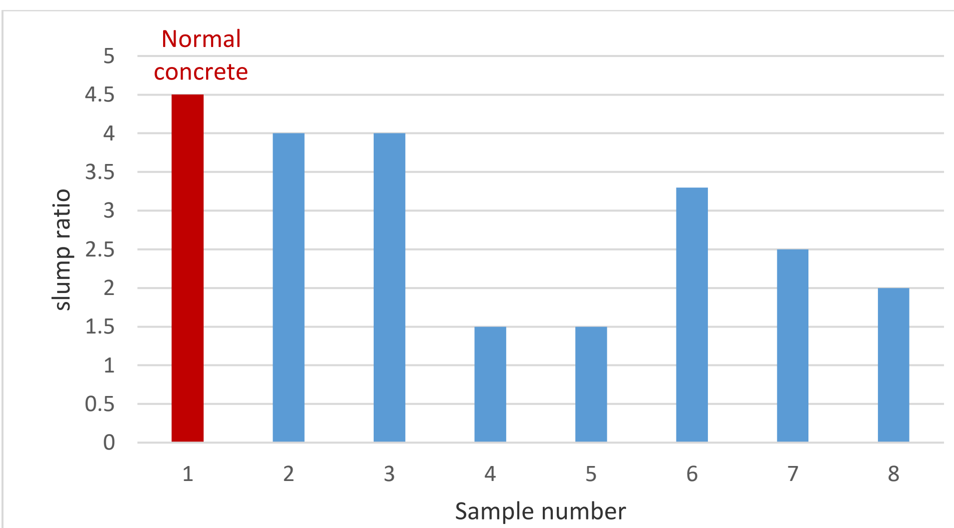

Figure 4. 7. Slump test

CHAPTER 5

CONCLUSION AND FUTURE RECOMMENDATIONS

5.1. Conclusion

The project objectives are achieved through the use of steel fiber waste as a mineral admixture. Relationship between steel fiber percentage and compressive strength is established. Control specimens exhibited compressive strengths of 18 Mpa (with 0.42 water-cement ratio) and 25 Mpa (with 0.40 water-cement ratio) at 7 days. At 28 days, control specimens showed strengths of 27 Mpa (with 0.42 water-cement ratio) and 30 Mpa (with 0.40 water-cement ratio). Steel fiber additions at varying percentages increased compressive strength, with a decline observed beyond 10%. Slump test results indicate a decrease in workability with steel fiber addition. Concrete mixes with 0.42 water-cement ratio exhibited slump ratios ranging from 4.2 to 1.5 cm. Similarly, mixes with 0.40 water-cement ratio showed slump values from 4.5 to 2 cm. Higher slump values correspond to greater workability, influenced by water-cement ratio and compacting factor.

5.2. Recommendations for Further Studies

To follow up this study would need to make some corrections so that further research can be better. As for suggestions for further research, include:

1. Cleaning the steel fibers from any grease and oily particles because the grease makes the steel fiber waste conglomerate at one point.
2. Using a chemical admixture together with the mineral admixture (steel fiber) so that the steel fiber is distributed uniformly and does not conglomerate all in one place.
3. Need to research with a different ratio of steel fiber and different water- cement ratio.
4. Further study on the performance of concrete using different types of mineral admixture.

APPENDICES

Preparation of Samples

Figure 1. Mixing of the concrete ingredients

Figure 2. Compaction of the concrete in the cubes

Figure 3. Concrete cubes before hydration

Slump Test

Figure 4. Slump test

Compression Test

Figure 5. Compression test

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