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EFFECT OF THE CONTENT OF MICRO SILICA AND SUPERPLASTICIZER ON THE STRENGTH OF CONCRETE

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ABSTRACT

Concrete is the most popular construction material everywhere in the world. It is the second most consumed material, next to the water. From a historical point of view, in the middle of the 20th century, concrete with characteristic strength of 30 MPa was considered high-strength concrete and later in the 1980s, Concrete is said to be HSC when the compressive strength exceeds 50 MPa. Nowadays, HSC has sufficiently advanced such that concretes with compressive strengths of more than 120 MPa are commercially known as high-strength concrete that can be produced in laboratories.

In this study, Laboratory tests were performed in the Lohara Khola bridge site and Ruma Khola bridge site with the bridge span 25-meter meter to investigate the ranging percentage of silica and superplasticizer on compressive strengths of the different mix proportions of concrete. A total of 12 trail mix proportions were used for the tests. Those were compared with the approved field applied test. Primary data were collected in laboratory tests whereas secondary data were collected from standard specifications for road and bridge-2073 and Is 10262: 1982. These data were analyzed by regression analysis for the comparison between micro silica and superplasticizer verse average compressive strength in MPa.

From 7 days and 28 days of concrete cube tests, it was found the increasing trend of the compressive strengths while increasing the content of the silica. The relationship between the content of micro silica and Superplasticizer with the compressive strength was found almost linear. From the experiment results, the optimum content of micro silica and superplasticizer were found by 5 % and 1.25% respectively by weight of cement for bridges, roads, and other structures. Among these different types of material used in concrete, micro silica, and superplasticizer have high strength than the rest of the other admixtures by doing 12 trial mixtures in a laboratory test in the field. Also, from several test results, the strength of concrete in the Lohara bridge site and Ruma bridge site have used normal concrete strength (NSC). In these sites, if micro silica and superplasticizer were used the strength of concrete may increase

up to the level of moderate-high strength concrete which make the bridge high load-bearing capacity and more durable.
Therefore, to make the bridge structures of higher strength and more durability, the use of micro silica and superplasticizer becomes necessary in the bridge construction sites.

KEYWORDS: *superplasticizer, concrete, durability, construction, investigate.*

INTRODUCTION

Mostly in the world, Concrete material is used in the construction field. For many years ago, lightweight aggregate has been used for structural purposes. They are normally working in structures for which the dead load participates in a major part of the total load. Lime and Portland cement are used as the binder. By using such aggregates, structural lightweight concrete with 28-day compressive strength of up to 30 MPa has been produced. higher adhesion between reinforcing steel and concrete, and enhanced durability characteristics, are special properties of lightweight concrete that make it different from normal-weight concrete (Erhan, et al., 2015).

From a historical point of view, in the middle of the 20th-century concrete with characteristic strength of 30MPa was considered high strength and later in the 1980s, Concrete is said to be high-strength concrete when the compressive strength exceeds 50 MPa. Nowadays, HSC has sufficiently advanced such that concretes with compressive strengths of more than 120MPa are commercially known as high-strength concrete that can be produced in laboratories (Ajay & Mahesh, 2021). Several methods exist for the mix design of strength of concrete. The overall purpose of the mixed design method was first developed by Okamura and Ozawa (1995).

The high flow ability of self-compaction concrete mixtures is achieved by using a super plasticizer which influences many fresh and hardened properties of concrete mixtures. Nippon Shokubai and Nippon Master Builder Technology invented the polycarboxylate-based super plasticizer (PC) in the middle of the 1980s in Japan. The effect of the type of new generation super plasticizer, air-entraining, viscosity modifying, and anti-foaming admixtures on the air content and workability for high performance of concrete (Ali Mardani, et al., and 2013).

Ordinary Portland Cement (OPC) is used in all test specimens, the tests are carried out on the used cement to determine its physical properties according to the Egyptian Code of Practice. Fly ash and silica fume are used as a replacement for the cement content by different percentages to reduce the dosage of chemical admixtures needed. The suitable percentage of fly ash, and silica fume that gives the highest value of concrete compressive strength. Its self-weight with little or no vibration effort gives cohesion enough to be handled without segregation or bleeding of fresh concrete. These mixes usually contain super plasticizers, silica fume, high content of fines, and/or viscosity-modifying additives (Mohamed, 2011).

Silica fume is a mineral admixture that improves mechanical properties and reduced permeability. Secondly, the super-plasticizer (SP) is a chemical admixture used for water-reducing, increasing cohesiveness, improve the passing and filling ability of the strength of concrete (Waseem Khairi, et al., 2020).

Super plasticizers are chemical admixtures used where well-dispersed particle suspension is required. They have become indispensable constituents of any designed cement mortar mix today. The property of fresh and hardened cement mortar is strongly influenced by the interaction of super plasticizers and cement Conventional concrete is a cost-effective material that is relatively easy to make, transport, and place (Alsadey & Omran, 2018).

The water/powder (cement, fly ash, limestone filler, silica fume, etc.) ratio of mortar and the type of chemical admixtures should be determined, to place the fresh mortar without any external compaction and at the same time without causing any segregation (Burak, et al., 2006).

Research Question

Based on the above problems, the following research questions are formulated:

- What is a suitable ratio of Silica and Super plasticizer on strength of concrete?
- How to compare the concrete strength between Field works and Laboratory test works?

Research Objectives

The main objective of the research is to determine the effect of the content of silica and super plasticizer on strength of concrete. The Specific objectives of the study are:

- To determine a suitable ratio of Silica and Super plasticizer on strength of concrete.
- To compare the concrete strength between Field works and Laboratory test works.

Significance of the study

The study is helpful to choose the suitable ratio of binder used on high-strength concrete for many structural works in the construction field. It reduces the cost of construction and the long life of the concrete and minimizes cracks like i.e. Shrinkage cracks, creep cracks, hairline cracks, etc. The study also suggests a better ratio of silica and Super plasticizer.

The study has seen various types of binder used on high-strength concrete for bridges and roads by using appropriate types of binder, which are more cost-effective, have longer life spans with higher durability and less maintenance; adaptability to new traffic; improved reliability and safety; environmental friendliness; easier and faster construction.

RESEARCH METHODOLOGY

The data was collected from different sources which were analyzed and verified. This chapter discusses the various frameworks, methodologies, and underlying theories used in developing appropriate admixtures and the suitable types of admixtures. The methodology was designed not only to address the study objectives but also to help facilitate reliable data analysis and interpretation that is critical for studies of this nature. Various steps adopted for completing the research are mentioned in figure 3.1.

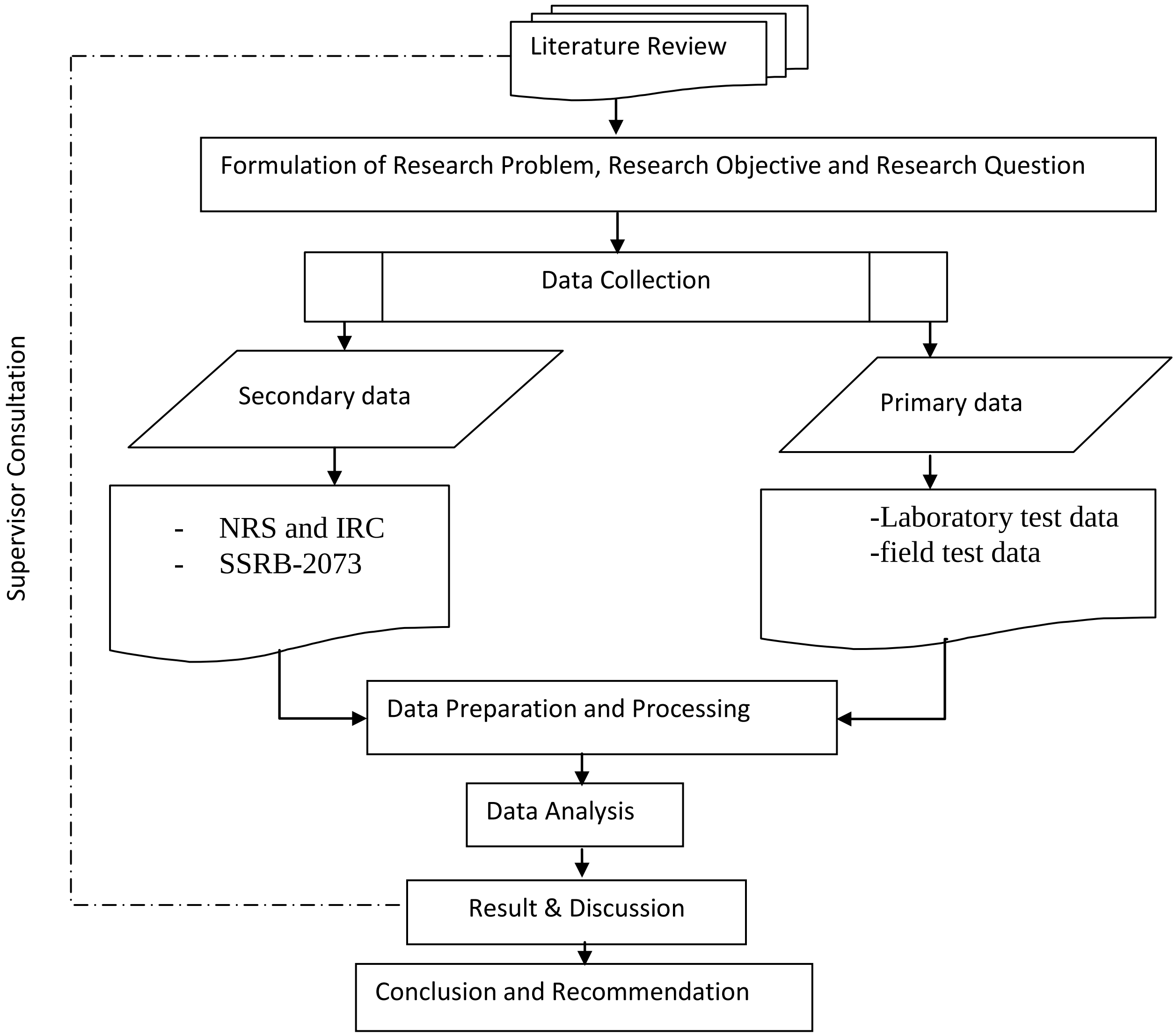

Figure 3.1: Research Flow Chart

Two Bridge locations of the Mid Hill Highway were taken as a study area where several laboratory test trials have been done for this research work. These two locations along Mid Hill Highway are Lohara Bridge and Ruma Bridge which is situated in the hilly region of Nepal. These road sections are characterized by highly broken relief with vastly differing elevations, steep slopes, and geological condition varies from place to place figure 3.2. These bridges are double-lane road bridges where Lohara Bridge was selected 25-meter span bridge, whereas Ruma Bridge was selected 25-meter span bridge.

Lohara Bridge Location

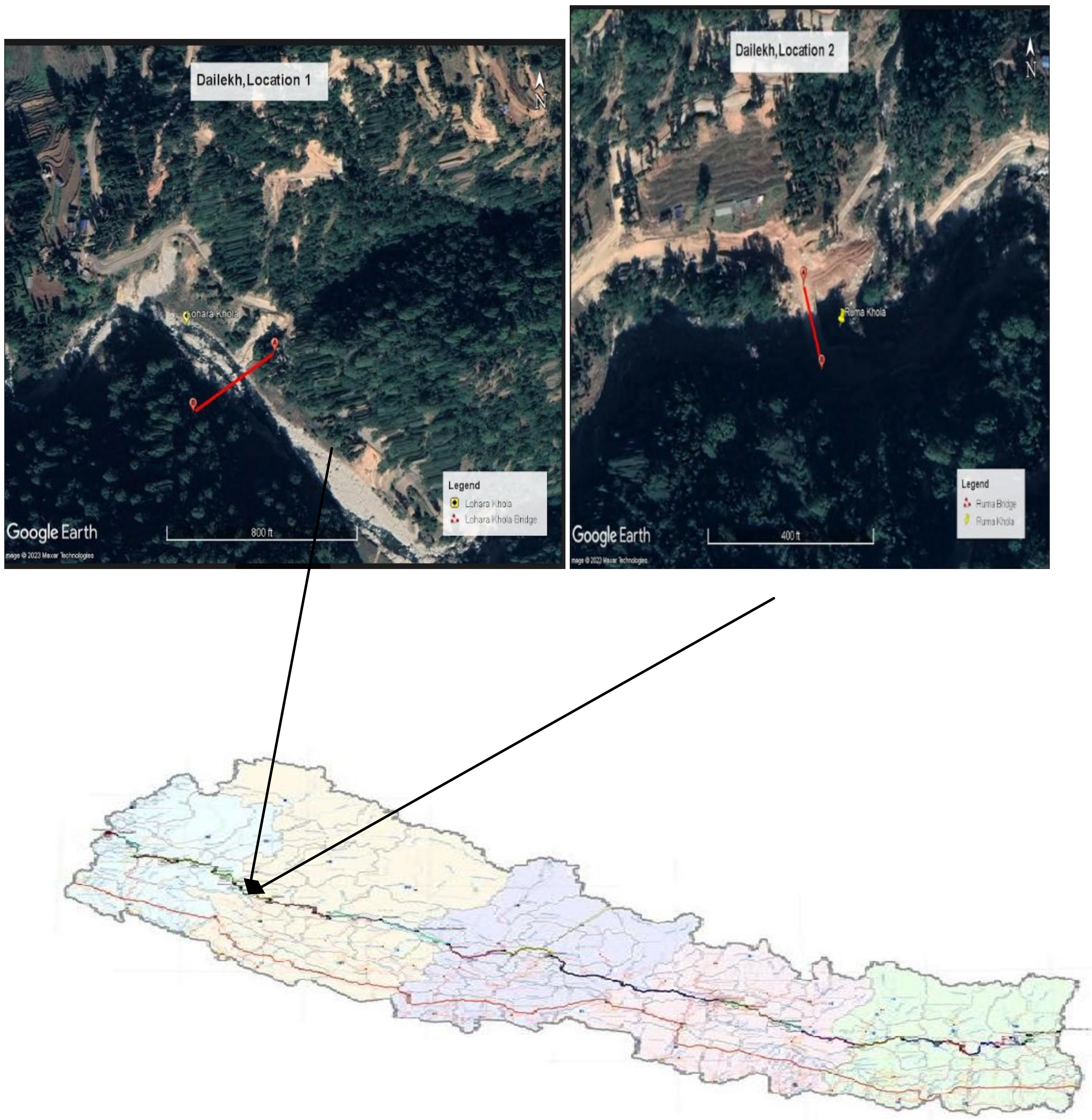

Figure 3.2: Map of Mid Hill Highway

Source: (Google Map)

Data Collection

These are ways used to gather information from various sources. Primary data were collected by Laboratory tests, measurement and calculation, and also Field investigation whereas secondary data were collected Standard Specification for Road and Bridge and Indian Road congress, etc. The following information was required for this study, Number of a cube, Date of casting, Age of concrete, strength of concrete, and weight.

Primary Data

The primary data were collected through Laboratory Tests and Field Tests. This was focused to address the following Cubes test:-

Number of Cubes

Date of Casting

Date of Testing

Age

Dimession

Surface Area (mm2)

Volume (m3)

Weight (KG)

Density (kg/m3)

Breaking Load (KN)

Breaking Strength (MPa)

Average Breaking Strength

Compressive strength(MPa)

Secondary Data

Secondary data refer to the data which have already been collected and analyzed by someone else. Most of the data were collected by Standard Specification for Road and Bridge works(2073) and Indian Road Congress IRCs 10262: 1982, Some of the data were collected from the literature.

Data collected by Standard Specification for Road and Bridge works(2073) and IRCs are:-

Initial setting time

Final setting time

Aggregate Percentage

Fine sand percentage

High-range water-reducing admixture

Water/Cement (W/C Ratio)

Data collected from the literature are:-

Strength of concrete

Cement percentage

Silica fume Percentage

Mix Design

The M50 grade of the HSC mix has been designed based on Indian standard IRC 10262: 1982. The details are given in the flow chart below.

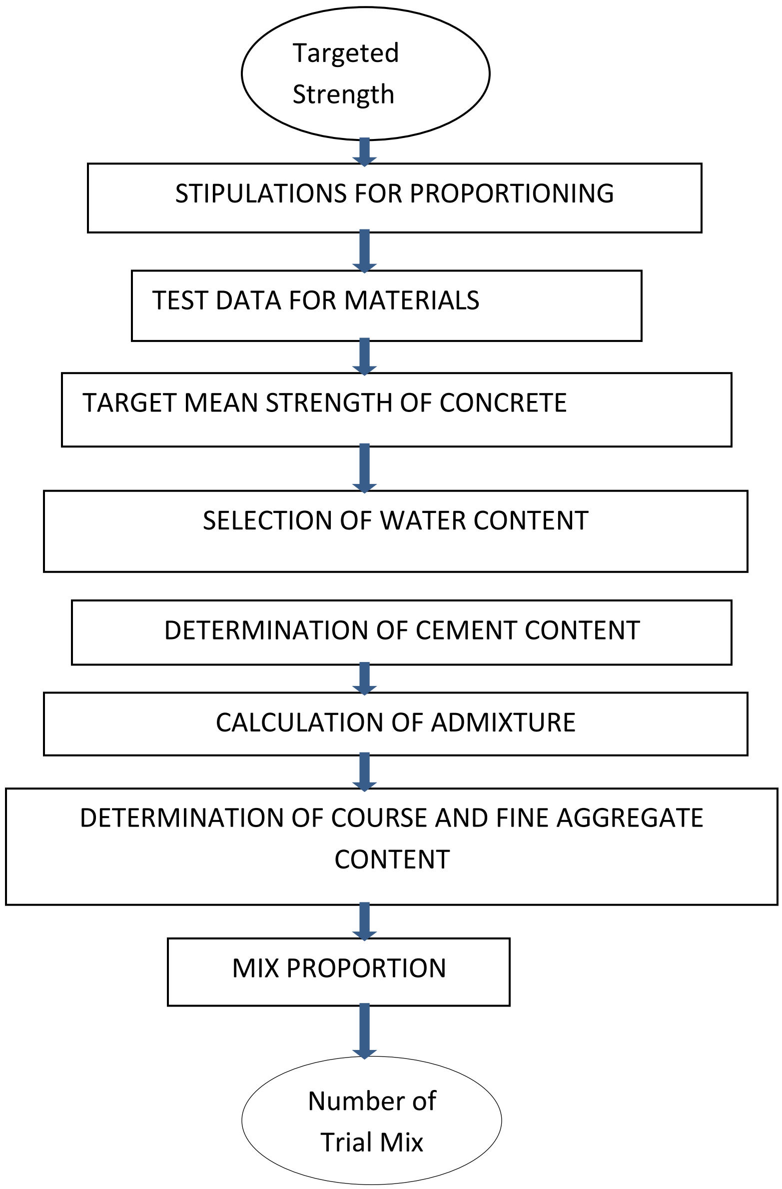

Figure 3.3: Mix Design

Data Analysis

This study was based on the quantitative method. Quantitative analysis was done by comparison of well-known standards and calculations on MS Excel software. This study finds a suitable ratio of Silica and Superplasticizer in high-strength concrete for these calculation Regression analysis was used. By using statistical average calculation and these value was compared with Standard Specification for Road and Bridge in the form of numeric value. These manipulations were presented in the form of graphical representation, i.e. Line chart, and tabulation. Appropriate types of admixture were analyzed from Statistical averages in terms of percentage or number and analysis by logical tools i.e. greater than or less than after that compare with each other. These manipulations were presented in the form of a graphical representation, i.e. Line chart.

Finally, the strength of concrete between Field works and Laboratory test works were investigated by comparing with each other by using well-known standards and calculations on MS-Excel software. The manipulations were also presented in the form of a Bar chart, and tabulation after that was compared with Fieldworks and Laboratory tests of concrete strength.

Research Matrix

The data collection, analysis and its conclusion process are mentioned in this table 3.2:

TABLE 3.1: RESEARCH MATRIX

Objective	Data required	Collection Technique	Analytical tools	Expected outcome
To determine a suitable ratio of Silica and Superplasticizer strength of concrete.	Primary data: • Weight (KG) • Density (kg/m3) • Breaking Load (KN) • Breaking Strength (MPa) • Strength of concrete Secondary data: • Fine sand percentage • Stength of concrete • Cement percentage • Silica fume Percentage	Field Test, Laboratory test, and specification of Road and bridge of DoR, IRC	Average statistical by MS-excel with Linear Regression analysis	Finding suitable ratio of Silica and Superplasticizer in high strength concrete.
To compare the concrete strength between Field works and Laboratory test	Primary data: • Weight (KG) • Density (kg/m3) • Breaking Load (KN) • Breaking Strength (MPa)	Field Test, Laboratory test, and specification of Road and bridge of	simple arithmetic calculation by MS-Excel	Compare Field and Laboratory Test

works.	• Strength of concrete Secondary data: • Fine sand percentage • Stength of concrete • Cement percentage • Silica fume Percentage	DoR, IRC		

RESULTS AND DISCUSSSION

It should be noted that the method described in this research paper deals with the effect of strength on high-strength concrete by using silica and superplasticizer by number by trial mixture test and identifying the suitable ratio of silica fume and superplasticizer. It also evaluates the appropriate type of binder used as an admixture on high-strength of concrete in the field as well as a laboratory test. In this study, several laboratory test trials have been done within the Lohara Khola bridge site and the Ruma Khola bridge site.

High strength concrete ratio by using silica and superplasticizer

In this study, the appropriate ratio was obtained through the Number of trail Mixtures of concrete by varying their percentage of ingredients. This ratio was compared with the standard specification for road and bridge and IS 10262:1982 Procedures and values. In the Standard specification for roads and bridges and IS, M50 concrete which has maximum compressive strength for 7 days, generally is in the range of 60 to 65% depending on Concrete Mix, and 28 days, 100% strength for concrete. Similarly, in IS maximum strength is 65 % and 100% for 7 days and 28 days respectively.

High Strength Concrete While Use In Silica Fume

From this compressive strength concrete for 7 days test trial by using Micro silica, it was seen when the percentage of micro silica was taken as zero percentage, the average compressive strength was 25.05 MPa which is a similar value to Lohara and Ruma bridge site laboratory test. When the percentage of micro silica was taken as 2.5% wt. of cement, average compressive strength was increased by 26.44 MPa, and it was seen when the percentage of micro silica percentage 3 % wt. of average compressive strength was increased by 26.88 MPa. Similarly, the ratio of micro silica percentage of 3.5 % wt. of cement's average compressive strength was increased by 27.2 MPa respectively which is shown in the figure below.

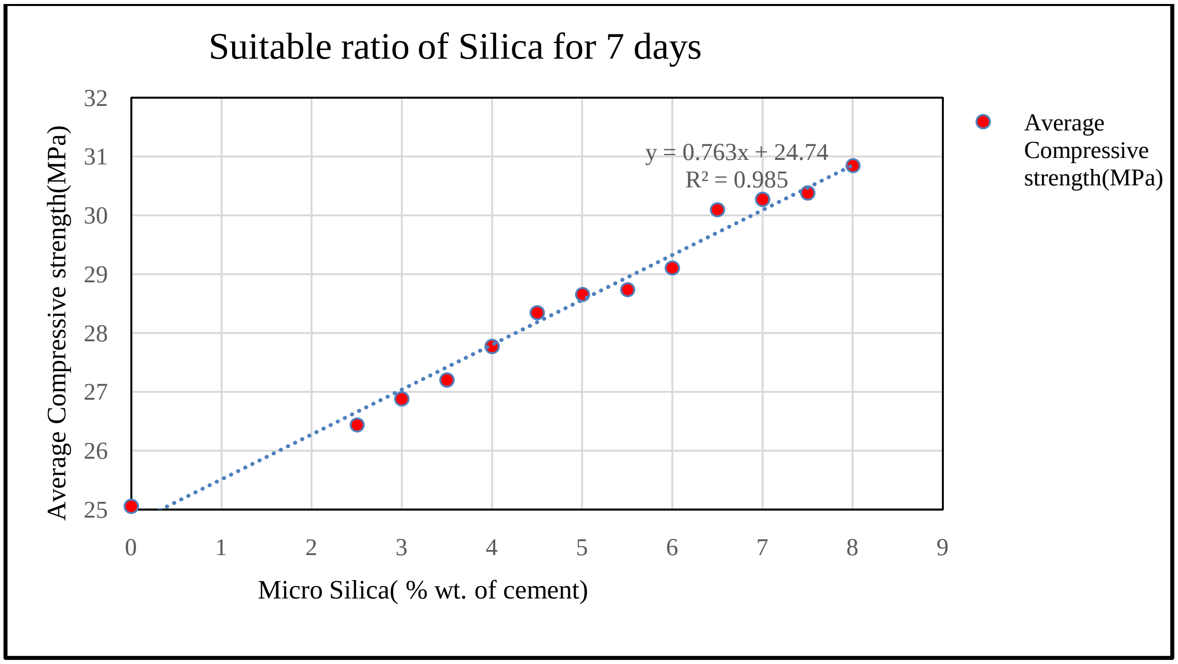

Figure 4.4: Suitable ratio of Silica for 7days of concrete

Hence, from the above figure, when the Micro silica percentage increases the average compressive strength also increases simultaneously.

The regression analysis between Micro silica and average compressive strength for 7 days had a significantly high linear relationship ($p<0.0001$), with the equation of Y=0.7633x+24.747 (R2=0.9853) from Appendix 1. There was a significant difference ($p<0.05$) between means of average compressive strength in a different range of micro silica. The detailed calculation was given in Appendix 1.

From this compressive strength concrete for 28 days test trial by using between Micro silica, it was seen when the percentage of micro silica was taken as zero percentage, the average compressive strength 39.25 MPa. It was seen when the percentage of micro silica percentage 2.5% wt. of cement average compressive strength was increased by 41.40 MPa, it was seen when the percentage of micro silica percentage 3 % wt. of cement average compressive strength was increased by 41.78 MPa. Similarly, the ratio of micro silica percentage of 3.5 % wt. of cement's average compressive strength was increased by 42.44 MPa respectively which is shown in the figure below. Hence, from the above figure, when the Micro silica percentage increases the average compressive strength also increases simultaneously

The regression analysis between Micro silica and average compressive strength for 28 days had a significantly high linear relationship ($p<0.0001$), with an equation of Y=2.042x+37.18 (R2=0.9116) from Appendix 1. There was a significant difference ($p<0.05$) between means of average compressive strength in a different range of micro silica. The detailed calculation was given in Appendix 1.

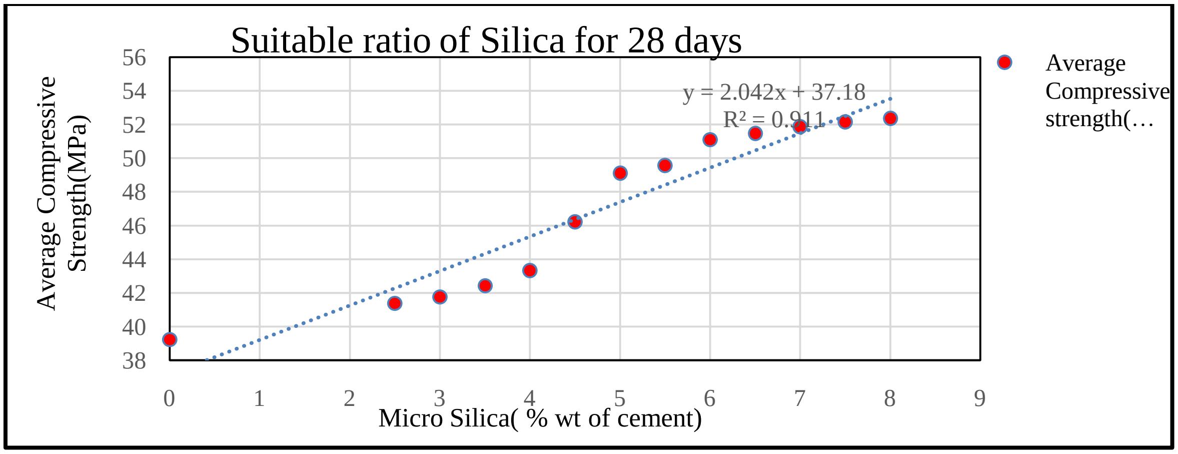

Figure 4.5: Suitable ratio of Silica for 28 days of concrete

Therefore, when the percentage of micro silica increase, the average compressive strength also increase. Thus, there was direct relation between Micro silica with the average compressive strength of concrete of high strength concrete (HSC). This indicates when Micro silica percentage low is not favorable to construct bridge and any structure in the context of safety, durability, and strength of construction structure. Whereas micro silica is very high is also not favorable in the context of cost of construction and environmental condition. Hence from statistical average calculation from appendix. Thus, this ratio is suitable for construction field to gain the strength and durability by minimizing high cost. The ratio of Micro silica were 5% as per IS 10262:1982. This ratio is an appropriate for Construction Bridge and road by comparison standards. It reduces all problems caused by very high and very low ratio of Micro silica.

From above 7days and 28days casting of concrete, if Micro silica increased then average compressive strength of concrete has been increased. There was a direct relation between micro silica with the compressive strength. It is also significantly affecting the appropriate type of admixture. Thus, the micro silica should be Chosen in 5 % wt. of cement for bridge, road and other structures, which is comparatively suitable ratio for mix design of concrete.

High strength concrete while use in Superplasticizer

From this compressive strength concrete for 7 days test trial by using between superplasticizer, it was seen when the percentage of micro silica was taken as zero percentage, the average compressive strength 25.01 MPa which is a similar value to like Lohara and Ruma bridge site. It was seen when the percentage of Superplasticizer 0.8% wt. of cement average compressive strength was increased to 25.86 MPa, it was seen when the percentage of superplasticizer 0.85 % wt. of cement average compressive strength was increased to 26.12 MPa. Similarly for a ratio of Superplasticizer percentage, 0.9 % wt. of cement average compressive strength was increased by 26.61 MPa respectively which is shown in the figure below. The regression analysis between Micro silica and average compressive strength for 7 days had a significantly high linear relationship ($p<0.0001$), with an equation of $Y=3.2469x+24.152$ ($R2=0.8145$) from Appendix 1. There was a significant difference ($p<0.05$) between means of average compressive strength in a different range of superplasticizers. The detailed calculation was given in Appendix 1.

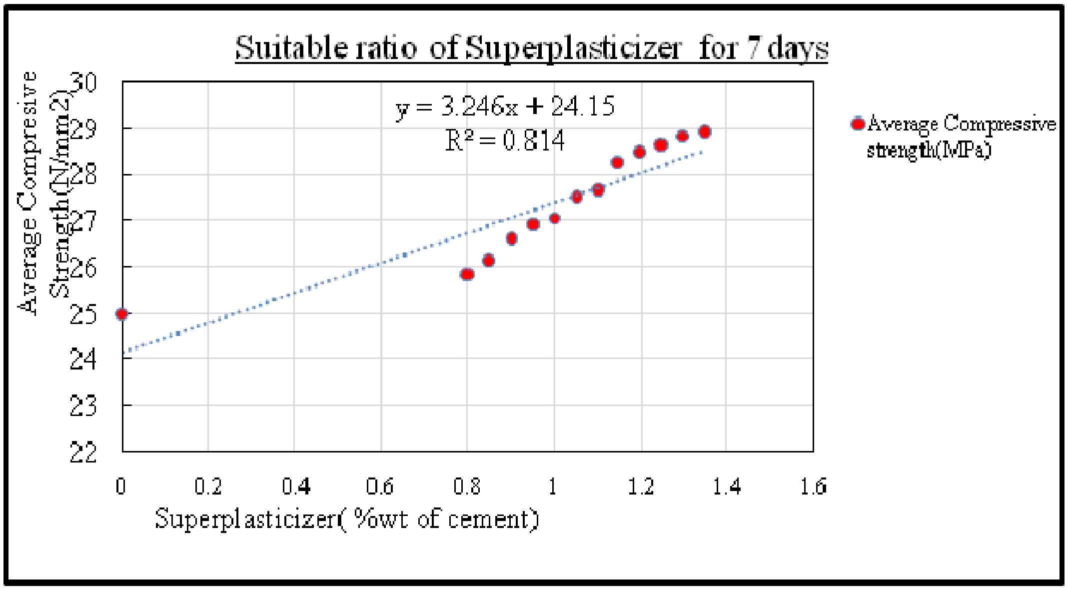

Figure 4.6: Suitable ratio of Superplasticizer for 7 days of concrete

From this compressive strength concrete for 28 days test trial by using Superplasticizer, it was seen when the percentage of micro silica was taken as zero percentage, the average compressive strength was 39.35 MPa which is a similar value to like Lohara and Ruma bridge site. it was seen when the percentage of Superplasticizer 0.8% wt. of cement average compressive strength was increased to 43.12 MPa, it was seen when the percentage of Superplasticizer 0.85 % wt. of cement average compressive strength was increased to 45.12 MPa. Similarly for a ratio of Superplasticizer percentage, 0.9 % wt. of cement average compressive strength was increased by 45.87 MPa respectively which is shown in the figure below. Hence, from the above figure when the Superplasticizer percentage increases the average compressive strength also increases simultaneously

The regression analysis between Micro silica and average compressive strength for 28 days had a significantly high linear relationship ($p<0.0001$), with an equation of $Y=12.696x+36.01$ ($R2=0.8029$) from Appendix 1. There was a significant difference ($p<0.05$) between means of average compressive strength in a different range of superplasticizers. The detailed calculation was given in Appendix 1.

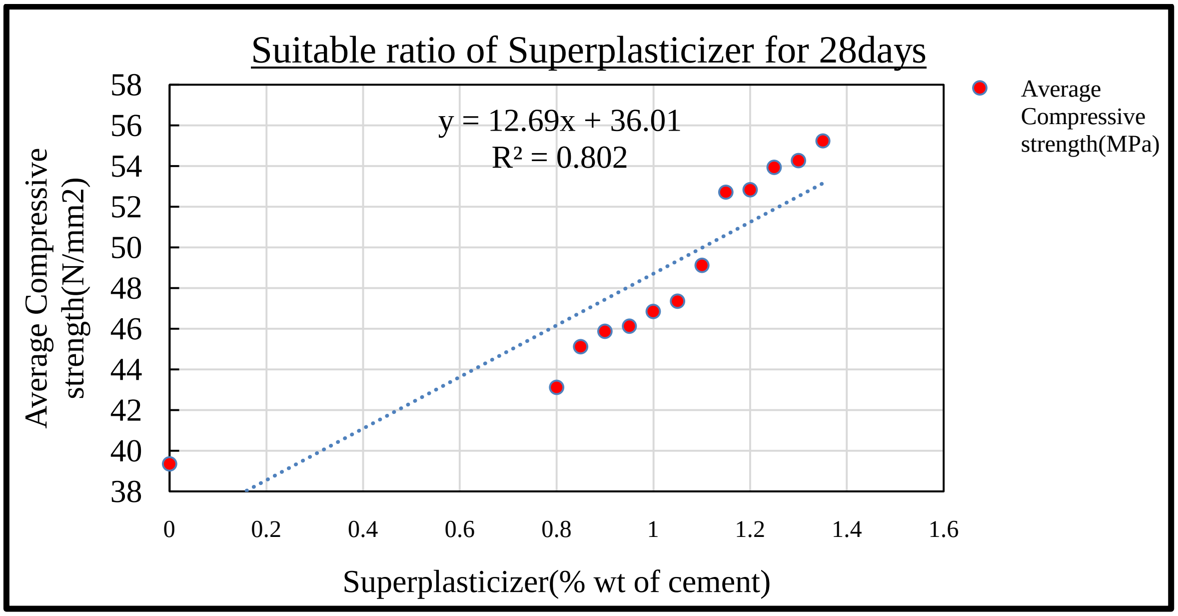

Figure 4.7: Suitable ratio of Superplasticizer for 28 days of concrete

Therefore, also when the percentage of Superplasticizer and flow gel increases, the average compressive strength also increases. Thus, there was a direct relation between Superplasticizer and flow gel with the average compressive strength of concrete of high-strength concrete (HSC). This indicates when Superplasticizer and flow gel percentage low is not favorable for constructing the bridge, roads, and any other structure for safety, durability, and strength of the construction structure. Whereas Superplasticizer and flow gel is very high is also not favorable in the context of the cost of construction and environmental condition. Hence from a statistical average calculation from the appendix, the Ratio of silica is between 5, and for Superplasticizer it is 1.25% wt of cement. Thus, this ratio is suitable for the construction field to gain strength and durability by minimizing high costs. The ratio of Superplasticizer and 1.25% as per IS 10262:1982. This ratio is appropriate for the construction of bridges and roads by comparison standards. It reduces all problems caused by a very high and very low ratio of Superplasticizer.

From the above 7-day and 28-day casting of concrete, if Micro silica, Superplasticizer, and flow gel increased then the average compressive strength of concrete has been increased. There was a direct relation between Micro silica, Superplasticizer, and flow gel with the compressive strength. It is also significantly affecting the appropriate type of admixture. Thus, the Superplasticizer value should be Chosen in 1.25% wt. of cement for bridges, roads, and other structures, which is a comparatively suitable ratio for the mix design of concrete in the construction field.

Different types of Admixture

Though several studies have considered the development of a balanced or standardized method of concrete mix design for High strength concrete. Sustainable high-strength concrete does not contain any special or unusual ingredients. A common mix includes cement, superplasticizers, micro silica fume, flow gel, fly ash, and slag, with a relatively large number of cementitious by-

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products for cement replacement. This led to various studies starting to produce concrete with higher strength where workability was a major challenge and the use of a superplasticizer made it possible and paved the way for the production of HSC (ACI, 1997).

Compressive strength of admixture for 7 days

This study contains four different types of admixture in laboratory tests on the Bridge location site. The average compressive strength of concrete was calculated for each type of admixture and compared with each other. For Cement only when twelve trial mixtures have been done in the laboratory, it has low strength of 26.11 MPa and high strength of 27.12 MPa, and detailed calculation was given in Appendix. For Fly ash and cement when twelve trial mixtures have been done in a laboratory, it has low strength of 25.46 MPa and high strength of 27.12 MPa. For Slag and cement when twelve trial mixtures have been done in a laboratory, it has low strength of 26.01 MPa and high strength of 27.23 MPa. For Micro silica and cement, it had low strength of 26.44 MPa and high strength of 30.84 MPa, and last For Superplasticizer when twelve trial mixtures have been done in a laboratory, it has low strength of 25.86 MPa and high strength of 28.89 MPa and detail calculation was given in Appendix. Therefore, there was a huge difference between the different types of admixture uses strength which is shown in the figure below.

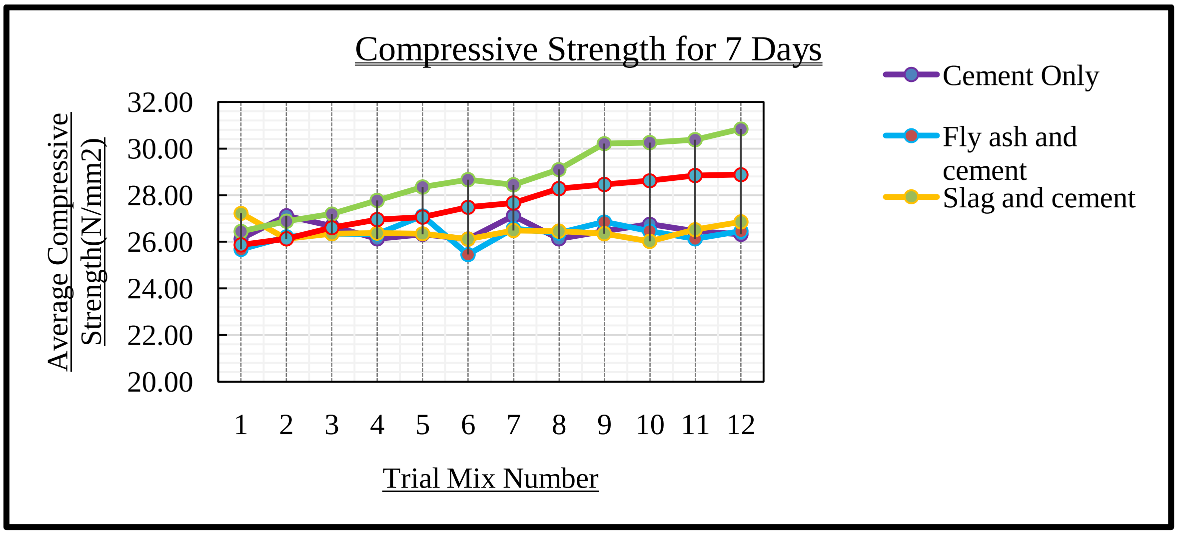

Figure 4.8: Different type of admixture compressive strength for 7 days

Compressive strength of admixture for 28 days

This study contains four different types of admixture in laboratory tests on the Bridge location site. The average compressive strength of concrete was calculated for each type of admixture and compared with each other. For Cement only when twelve trial mixtures have been done in a laboratory, it has low strength of 39.11 MPa and high strength of 39.87 MPa, and detailed calculation was given in Appendix. For Fly ash and cement when twelve trial mixtures have been done in a laboratory, it has low strength of 39.21 MPa and high strength of 40.32 MPa. For Slag and cement when twelve trial mixtures have been done in a laboratory, it has low strength of 39.54 MPa and high strength of 40.63 MPa. For Micro silica and cement when twelve trial mixtures have been done in a laboratory, it had low strength of 41.78 MPa, and high strength of 52.45 MPa, and last For Superplasticizer, it has low strength of 43.12 MPa and high strength of

55.25 MPa and detail calculation was given in Appendix. Therefore, there was a huge difference between the different types of admixture uses strength which is shown in the figure below.

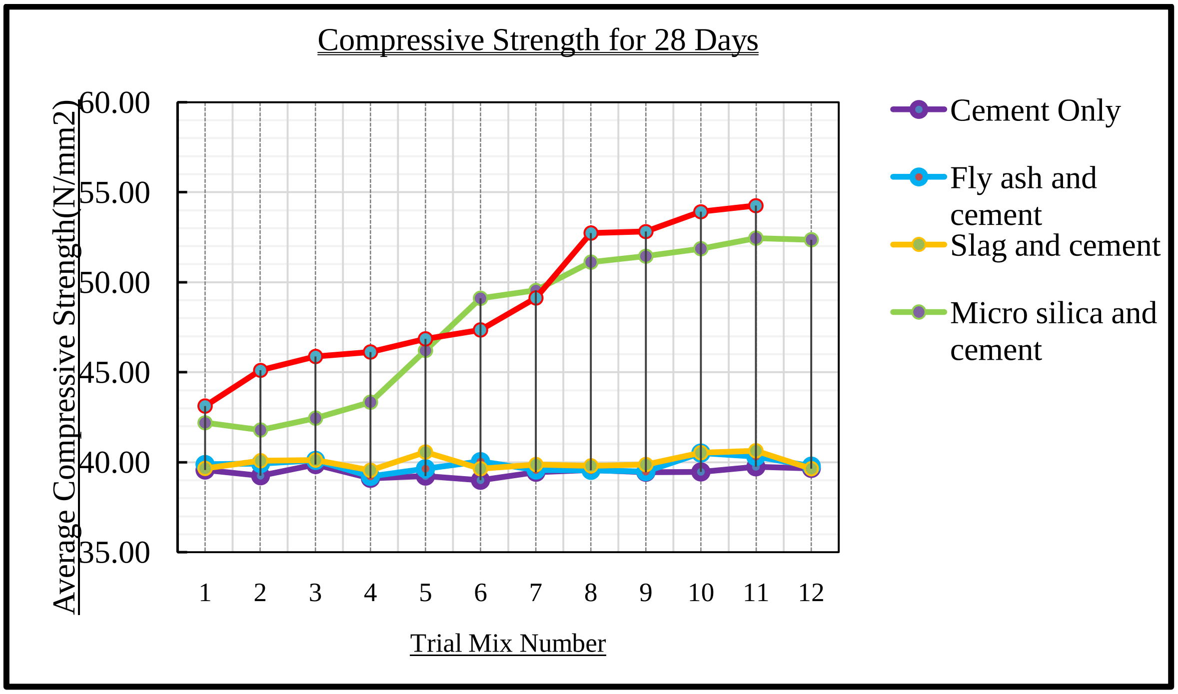

Figure 4.9: Compressive strength of admixtures for 28 days

From this study, among these different types of admixture Micro silica and superplasticizer have high strength than the rest of the admixture by doing 12 trial mixtures in a laboratory test in the field. Therefore high-strength concrete superplasticizer is the best admixture for use in bridges, roads, and other structures in construction fields.

Compare concrete strength of Lohara Bridge and Ruma Bridge test with Laboratory test

Topography is an important factor and influences the physical location of the Bridge. Geometric design standards are different for different terrain conditions. The hilly and mountainous regions are affected by valleys and deep gorges which increase the cost of construction and time of construction too. This study contains two different sites of a bridge with a double-lane carriageway spanning 25m. The following test result was found to compare this site and laboratory test.

Compare concrete strength of Lohara bridge test and Laboratory test

In the Lohara bridge site, when 12 trial mixtures have been done in a laboratory, TM1 it has a compressive strength of 26.20 MPa, TM2 it has a compressive strength of 27.16 MPa, similarly TM12 it has a compressive strength of 26.89 MPa found by investigation. For Micro silica and cement combination when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have were done in a laboratory, it has compressive strength 26.44, 26.88, 27.2, 27.77, 28.35, 28.66, 28.44, 29.11, 30.22, 30.25, 30.38, 30.85 MPa respectively. Similarly for superplasticizer when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have been done in a laboratory, it has compressive strength 25.86, 26.12, 26.61, 26.95, 27.06, 27.49, 27.66, 28.28, 28.46, 28.63, 28.84, 28.89 MPa respectively for 7 days.

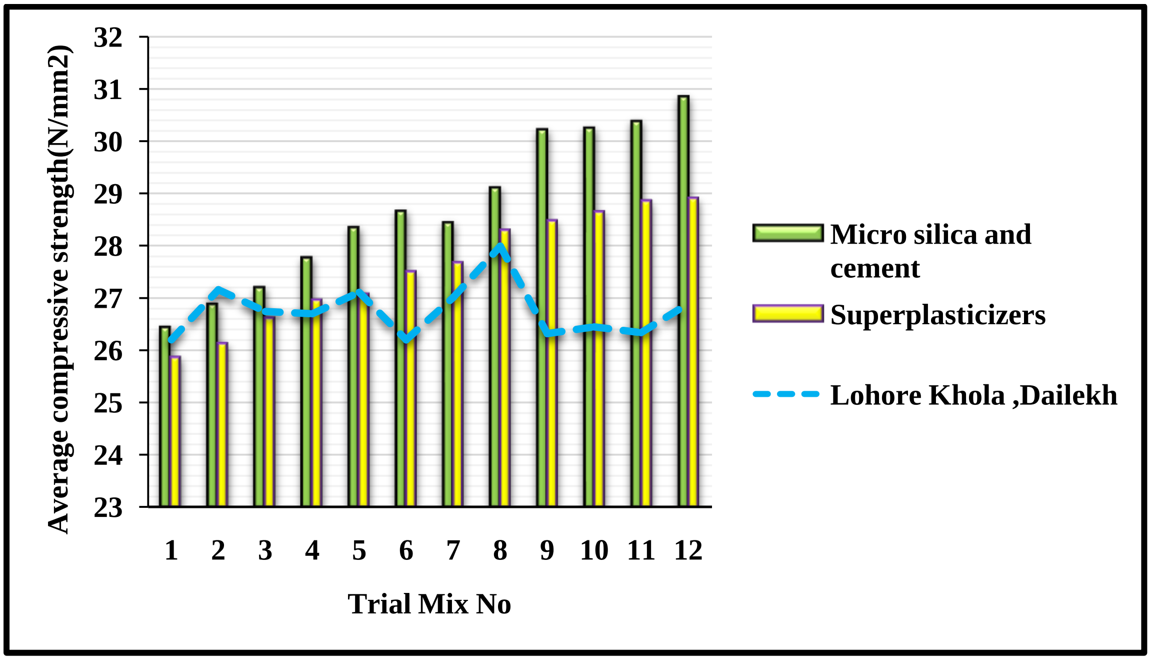

Figure 4.10: Comparing compressive strength for 7 days with Lohara Bridge site test

In the Lohara bridge site, when 12 trial mixtures have been done in a laboratory, in TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have been done in a laboratory, it has compressive strength 39.23, 38.93, 39.53, 39.23, 39.5, 39.21, 39.61, 39.34, 38.99, 38.96, 39.78, 39.4 respectively found by investigation. For Micro silica and cement combination when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have were done in a laboratory, it has compressive strength 42.20, 41.78, 42.44, 43.33, 46.22, 49.11, 49.56, 51.11, 51.46, 51.86, 52.45, 52.36 respectively. Similarly for superplasticizer when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have been done in a laboratory, it has compressive strengths 43.12, 45.12, 45.87, 46.12, 46.85, 47.35, 49.12, 52.73, 52.83, 53.93, 54.27, 55.25 respectively for 28 days.

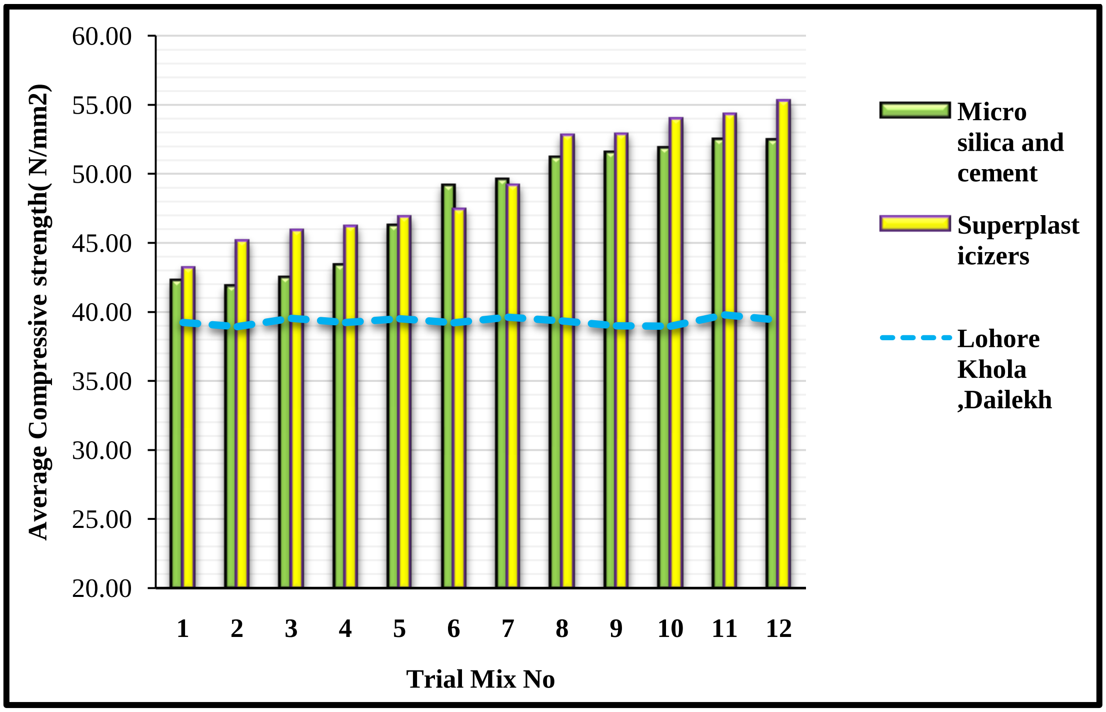

Figure 4. Comparing compressive strength for 28 days with Lohara Bridge site test

Hence, from these above test results, the strength of concrete in the Lohara bridge site has used normal concrete strength whereas the using of micro silica and superplasticizer strength of concrete makes high strength concrete which makes the bridge more durable and high load bearing capacity with little more addition of this types of admixture.

Compare concrete strength for 7days Ruma Bridge test and Laboratory test

In the Ruma Bridge site, when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have were done in a laboratory, it has compressive strength 26.42, 26.86, 26.27, 25.75, 26.42, 26.21, 25.53, 27.31, 25.09, 26.68, 26.64, 25.98 MPa respectively. For Micro silica and cement combination when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have were done in a laboratory, it has compressive strength 26.44, 26.88, 27.2, 27.77, 28.35, 28.66, 28.44, 29.11, 30.22, 30.25, 30.38, 30.85 respectively. Similarly for superplasticizer when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have been done in a laboratory, it has compressive strength 25.86, 26.12, 26.61, 26.95, 27.06, 27.49, 27.66, 28.28, 28.46, 28.63, 28.84, 28.89 MPa respectively for 7 days.

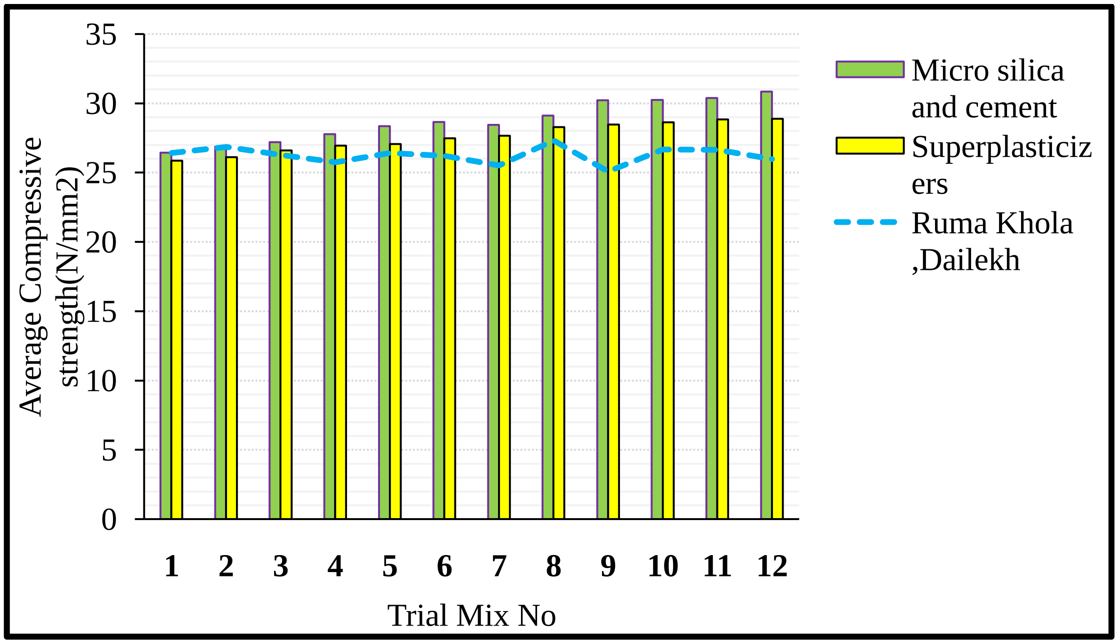

Figure 4.11: Comparing compressive strength for 7days with Ruma Bridge site test

In the Ruma Bridge site, when 12 trial mixtures have been done in a laboratory, in TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have been done in a laboratory, it has compressive strength 39.89, 39.59, 39.52, 40.18, 39.96, 39.74, 39.96, 39.34, 39.07, 40.85, 39.56, 39.81 respectively found by investigation. For Micro silica and cement combination when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have were done in a laboratory, it has compressive strength. 42.20, 41.78, 42.44, 43.33, 46.22, 49.11, 49.56, 51.11, 51.46, 51.86, 52.45, 52.36 respectively. Similarly for superplasticizer when twelve trial mixtures TM1, TM2, TM3, TM4, TM5, TM6, TM7, TM8, TM9, TM10, TM11, and TM12 have been done in the laboratory, it has compressive strength 43.12, 45.12, 45.87, 46.12, 46.85, 47.35, 49.12, 52.73, 52.83, 53.93, 54.27, 55.25 MPa respectively for 28 days.

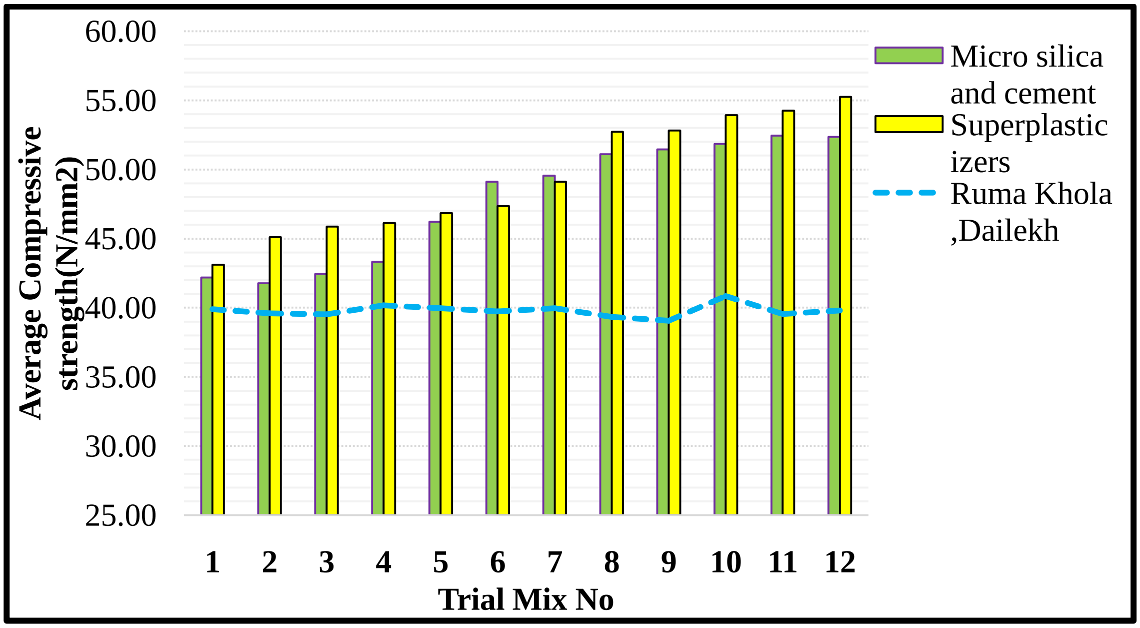

Figure 4.12: Comparing compressive strength for 28 days with Ruma Bridge site test

Hence, from these above test result, the strength of concrete in the Ruma bridge site has used normal concrete strength whereas the using of micro silica and superplasticizer strength of concrete make high-strength concrete which makes the bridge more durable and high load-bearing capacity with little more addition of this types of admixtures.

CONCLUSION AND RECOMMENDATION

Admixtures like Micro silica and superplasticizer appropriate ratio was obtained by a laboratory test in the field and compared with the standard specification for road and bridge, 2073 and IS 10262: 1982. It was found that the ratio of micro silica and superplasticizer 5% and 1.25% respectively weight of cement suitable for different grades of concrete strength. Micro silica and superplasticizer ratio increase with the increase the compressive strength and appropriate types of materials are found based on compressive strength that is superplasticizer and micro silica. While compare with this result on the Lohara bridge site and Ruma bridge site concrete test superplasticizers and micro silica type of admixture is needed to increase the strength of the bridge for more strength in any type of load and durability and environment friendly.

CONCLUSION

The specific conclusions of the study are as:

Therefore, from the above 7-day and 28-day casting of concrete when the percentage of micro silica and superplasticizer increase, the average compressive strength also increases. Thus, there was direct relation with the compressive strength of concrete. This indicates when Micro silica and superplasticizers have a low percentage is not favorable to construct a bridge and any structure in the context of safety, durability, and strength of the construction structure. Whereas micro silica and superplasticizer have very high percentages it is also not favorable in the context of the cost of construction and environmental condition. Hence, the Ratio of silica and superplasticizer has 5% and 1.25% respectively wt. of cement for bridges, roads, and other structures, which is a comparatively suitable ratio for the mixed design of concrete.

Different type of materials used in these studies is Cement, Fly ash and cement combination, Slag and cement combination, Micro silica fume, and Superplasticizer (SP). After several trial mixture tests in the laboratory, the conclusion was drawn by Micro silica and superplasticizer have high strength than the rest of the admixture. Therefore, high-strength concrete superplasticizer and micro silica fume is the best admixture for use in bridge, road, and other structure in construction fields.

Lohara bridge site and Ruma bridge site use concrete like normal strength concrete (NSC) because it has an almost compressive strength of 26 MPa for 7 days and 39 MPa for 28 days which is Normal strength concrete (NSC) but for high strength concrete it must be above M50 concrete. Thus micro silica and superplasticizer increase the strength of concrete make High strength concrete (HSC) which makes the bridge more durable and high load-carrying capacity by the addition of this type of admixture.

Recommendation

For the study following could be recommended:

Admixtures like silica and superplasticizer make the concrete high strength concrete so Micro silica and superplasticizer should choose 5% wt. of cement for bridges, roads, and other structures, which is a comparatively suitable ratio for the mix design of concrete.

Superplasticizer is the best admixture for high-strength concrete (HSC) for bridges, High rise buildings, roads, and other structures in construction fields.

Normal-strength concrete (NSC) has low strength than High strength concrete (HSC). So for a more durable and high load carrying capacity, safety environment-friendly structure, NSC is replaced by HSC by additional admixture available in the market.

Scope for further study

Recommended for further study as below:

This study could not cover the different type of admixture which is available in market.

A similar type of study can be done by a different method by cylinder cube test with a number for test trial mix and the result can be compared with the cube test for each substitute separately.

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