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ADDITIVE SELECTION IN READY MIXED CONCRETE

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ADDITIVE SELECTION IN READY MIXED CONCRETE

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Hasan Kalyoncu University

Supervisor

Assoc. Prof. Dr. Amjad KHABAZ

BY

Ali ELMAS

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ABSTRACT

ADDITIVE SELECTION IN READY MIXED CONCRETE

Elmas, Ali
M.Sc. in Civil Engineering Department
Supervisor: Assoc. Prof. Amjad KHABAZ
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In this experimental study, it was aimed to produce a concrete with high strength, suitable workability and reliability in ready-mixed concrete plants using silica fume and fly ash fluidizing additives. A total of 9 sets of experiments were conducted. The cubes are 15x15x15 cm in size. Slip was kept constant in the 15-18 cm range. For this purpose, 9 series of concrete are produced in case of substituting 1.25% super and hyper-fluidizer as chemical additives, 5%, 7.5%, 10% silica fume as mineral additives and 20%, 30%, 40% fly ash with cement., 3., 7., 28., 56. and 90. pressure resistances were tested on days. In addition, the compressive strength gains of these series were compared. The results of the experiment showed that fly ash has a healing effect on the processing of fresh concrete and can produce positive results in the long term in terms of its strength properties. Silica fume negatively affected the workability of fresh concrete, but it produced good results in the short term in terms of strength properties.

Key Words: In Ready-Made Concrete, Addıtıve, Selection

ÖZET

HAZIR BETONDA KATKI MADDESİ SEÇİMİ

Elmas, Ali
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Bu deneysel çalışmada, silika dumanı ve uçucu kül akışkanlaştırıcı katkı maddeleri kullanılarak hazır beton tesislerinde yüksek mukavemetli, uygun işlenebilirlik ve güvenilirliğe sahip bir beton üretilmesi amaçlanmıştır. Deney 9 takım olmak üzere toplam yapılmıştır. Küpler 15x15x15 cm boyutundadır. Kayma 15-18 cm aralığında sabit tutuldu. Bu amaçla, kimyasal katkı maddesi olarak %1.25 süper ve hiper akışkanlaştırıcı, mineral katkı maddesi olarak %5, %7.5, %10 silika dumanı ve çimento ile %20, %30, %40 uçucu kül yerine 9 serisi beton üretilmektedir., 3., 7., 28., 56. ve 90. basınç direnci birkaç gün içinde test edildi. Ek olarak, bu serilerin basınç dayanımı Kazanımları karşılaştırılmıştır. Deney sonuçları, uçucu külün taze betonun işlenmesi üzerinde iyileştirici bir etkiye sahip olduğunu ve mukavemet özellikleri açısından uzun vadede olumlu sonuçlar verebileceğini göstermiştir. Silika dumanı, taze betonun işlenebilirliğini olumsuz yönde etkiledi, ancak kısa vadede mukavemet özellikleri açısından iyi sonuçlar verdi.

Anahtar Kelimeler: Hazır Beton, Katkı Maddesi, Seçim

To my precious family…

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

%	value
C_3A	Trikalsiyum Alüminat
C_4AF	Tetrakalsiyum Aluminoferrite
E_{cj}	"J" daily elasticity modulus of concrete
fck	Concrete characteristic compressive strength
fctk	Concrete characteristic axial tensile strength
G_i	Total fixed load on the ith floor of the building
HP	Hyper Plasticizer
HPC	High Performance Concretes
LS	Lignosulfates
LS	lignosulfonate
Mm	millimeter
MPa	Megapaskal
MSF	Melamine Sulfonate Formaldehyde
NSF	Formaldehyde
^oC	Degrees Celsius
PC	Polycarboxylate
pH	Power of Hydrogen
SO_3	Sulfur
SP	Superplasticizer
TRMCA	Turkish Ready Mixed Concrete Association
TSİ	Turkish Standards Institution
USA	United States of America

CHAPTER 1

INTRODUCTION

Today, the most used building material is concrete. No matter what purpose it is produced for, it must have absolutely three main qualities.

- Traceability
- Strength
- Resistance to external influences

These three main features are seen as the elements that guide the composition of concrete. For 150 years, Cement has been used as a binding agent in manufactured concretes. However, research is continuing on alternative binders or materials that may be replaced by cement. Many natural and artificial materials with puzzolanic properties have been used for various purposes in the construction and concrete production from ancient times until today.

These substances, which are not the basic components of concrete, are organic and inorganic chemicals that are involved in very low amounts of concrete. They develop various physical, mechanical and durability properties of fresh and hardened concrete by participating in or after the production of concrete with the aim of changing the properties of cement in a good way and to a certain extent. So each component has properties that it should have. For a good concrete production, it is necessary to know the components well.

If we look at Turkey and the world in general, the production of concrete has almost completely left its place in the Ready-Mixed Concrete sector. While the production of C18 and lower strength concrete in Turkey has declined from 90% to 5% in the last ten years, in 2006, the implementation of projects under the C25 strength class was completely prohibited by some city municipalities. Moving ready-made concrete around the world towards high-strength concrete production;

- Increasing public awareness and user requests with developing technology,
- To think more about the concept of' durability ' during the project stages of the structures,
- There is not much cost difference between strength classes,
- Earthquake and natural disaster facts can be considered as causing serious damage.

In terms of economic, technological and ecological considerations, the importance of additives that can be replaced with cement in concrete is great. In recent years, with the spread of high strength concretes, the use of reinforced concrete in high structures has reached a level that can compete with the use of steel. These contributions can be divided into two main groups::

- Chemical Additives
- Mineral Additives

Begimgil and Dogan, in their experimental study, it was aimed to gain the economy of silica smoke and for this purpose, 300 doses of BS 35 concrete with a collapse value of approximately 10 - 11 cm was poured using normal fluidizer and selected as the reference concrete by using PC 42.5. In the second step, a superfluidizer is added to the mixture ratio of the selected reference concrete, again with a constant 10 - 11 cm slump value of 2. series concrete samples were produced. In the third step 5%, 10%, such as different proportions of silica smoke, superfluidizer mixture is added 3. and 4. series concrete samples were produced. 3 of these four series produced., 7. and 28. daily pressure resistance tests were performed and compared. In this study, we tried to show how silica fumes positively affect concrete performance and optimum utilization rate (Begimgil and Dogan, 1998).

Yazıcı, the performance of fluidizers belonging to six different commercial companies with the same chemical principles in concrete was examined. Fresh concrete experiments and compressive strength tests were conducted on the produced concrete. The data obtained has been compared to specifications. As a result, different results were obtained in terms of processing and strength with the same aggregate, the same dosage and the same cement, although they were based on the same fluidized materials. In addition, it has been suggested that problems can be encountered in concrete with fluidizing additives in the hours after production (Yazıcı, 2002).

Uyan and Yıldırım, they investigated the effects of superfluidizers on the bending and compressive strength of hardened concrete with the processing of fresh concrete. They tried 3 additives of neftalin origin obtained from different companies in two separate dosing concrete. He suggested that the increases in bending and compressive strength in the first ages due to the effect of the additives used were greater than the later increase rates. Although the additives used are the same based, it has been suggested that they give the desired strength increase and the same efficiency in terms of processing at different contribution percentages is the most important result of the study (Uyan and Yıldırım, 1991).

Dinçer ve Çağatay by weight instead of cement in his works% 0, % 5, % 10, % 20, % 30, % 40 fly ash was used in its proportions. 7 to determine the mechanical properties of mixtures., 14., 28., 90., 180. And 365-day-old concrete samples were produced. This research showed that the effect of fly ash substitution instead of cement on the mechanical properties of concrete is very good up to 20% fly ash substitution and can be used up to 30% (Dinçer ve Çağatay, 2004).

Özturan, his study showed that fly ash obtained at soma thermal power plant does not have a healing effect on the processing of fresh concrete in cases where it is substituted with cement at 25% to 50% by weight in the production of concrete, but it can produce positive results especially in the long term in terms of its strength properties (Özturan, 1991).

The 28 days Cube compressive strength of 60 MPa standard for study of chemical additives produced by using high strength concrete with different properties, these concretes after exposed to different curing time freeze-thaw durability against the effect of temperature and water permeability properties were examined. Concrete pressure resistance tests were conducted at certain times and the decreasing effect of factors affecting this durability on strength was investigated (Volkan, 2007).

Ravina, in their experimental study, Mehtan examined the effect of 35 - 50% displacement of fly ash and cement on the compressive strength of weak concrete mixtures by using two ASTM Class F and two ASTM Class C fly Ashes. The results of the analysis showed that fly ash, especially from weak concrete, has a significant effect on the properties of fresh and hardened concrete (Ravina, 1988).

Kemalettin Yilmaz, Mansür Sümer and Müttaba Uysal "the effect of different types of Fluidizing additives on high strength concrete" studies investigated the effects of different types of fluidizing additives on high strength concrete produced using black and white cement. Early and late strength of mixtures prepared with the same consistency were measured and analyzed. As a result, cement type and dosage is effective in high strength concrete construction, cement dosage is increased to a certain amount affects early strength, white cement mixtures concrete 28. after the day, it was observed that it provides a faster strength increase than black cemented mixtures, when the samples were examined, the breakages were from aggregates and it was observed that higher strength concrete production could be made by using high strength aggregates (Yılmaz et al., 2005).

In Saraswathy et al studies, they made fly ash more effective by using physical, chemical and thermal methods to accelerate the hydration of the cement - fly ash mixture. Fly ash, which they make more active using various methods, replaces cement % 10, % 20, % 30,% 40 7 of the mixtures obtained by using ratios., 14., 28. and 90. they examined daily pressure resistances and found that fly ash reinforced concrete with up to 30% increased pressure resistances (Saraswathy et al, 2003).

The aim of this research has been to investigate the effects on physical and mechanical properties of concrete using superfluidizer and hyper-fluidizer as chemical additives and fly ash and silica smoke as mineral additives. Therefore, it is an analysis of optimum cost and maximum performance and quality under engineering conditions to improve the quality of concrete and make it more durable, with increasing technology and developing community awareness.

For this purpose, mineral additives and chemical additives were used in concrete 1., 3. ,7. ,28., 56. and 90. the compressive strength of the concrete on the day was compared and the results were drawn. A total of 9 sets of experiments have been done and the cubes are 15x15x15 cm in size. The Slump was held constant in the 15-18 cm range. In the study, polycarboxylate-based hyper-fluidizer and naphthalene-based superfluidizer were used as chemical additives at 1.25%, silica fumes at 5%, 7.5% and 10% and fly ash at 20%, 30% and 40% were used as mineral additives.

CHAPTER 2

GENERAL CONTENT

2.1 Concrete

Concrete is a building material obtained by mixing aggregate (sand and gravel), cement, water and chemical that is used for certain purposes in necessary situations and mineral additives which are used in certain ratios. The properties of concrete are closely related to the properties of the materials used in the mixture and the mixing ratios. Concrete with different properties can be obtained by using materials with different features and some additives. When the materials that make up the mixture are combined and started to be mixed, concrete with a plastic consistency is produced as a result of the reaction of water and cement which is called hydration (Ersoy and Özcebe, 2001). Having a plastic consistency when it is produced is one of the most important features of concrete that makes it superior to other materials. Concrete poured into the chamber solidifies between 1-10 hours and gains strength over time. Solidification of the concrete is called stiffening, and obtaining strength over time is called hardening of the concrete. Concrete reaches 60% -90% of its real strength in the first 28 days. It takes many years for this value to reach 100%.

2.1.1 Cement

Cement is a material obtained by grinding a mixture of limestone and chalk after cooking at high temperature. This material is extremely important for the production of concrete and is a binder that solidifies when mixed with water. Interaction of cement with water and become solidified is called hydration. Cements can be found in various types according to their production methods and raw materials used in production. The most common type used in buildings is Portland Cement. Three standard strength classes are defined for cements. These are classified as 28 days compressive strength 32.5 MPa, 42.5 MPa and 52.2 MPa (Ersoy and Özcebe, 2001; Celep and Kumbasar, 2005).

2.1.2 Water

Water is needed in concrete production to provide chemical reaction in cement, wetting of aggregates and workability by wetting the mixture. However, it is very important for concrete which substances are contained in this water. The presence of chloride, sulfate, oil, sugar, and industrial wastes in the water contributes negatively to the strength of the concrete. In addition, water-cement ratio plays an important role for the strength of concrete. If this rate is low, the water-cement reaction will not be complete as expected, and if it is more, there will be small gaps in the concrete that will cause the resistance to decrease (Celep and Kumbasar, 2005).

2.1.3 Aggregate

One of the basic materials that make up the concrete is aggregate. It forms a hard and dense mass by bonding with cement and forms a 60-80% volume of the concrete. The most important factor in the strength of concrete is the occupancy rate of the aggregate. This depends on the fact that the granulometry of aggregate is favorable which the aggregate grain diameters in the mixture are in certain proportions. The granulometer also significantly affects shrinkage (contraction) and creep. Aggregates can be divided into two groups depending on their size: 0-6 mm in diameter, fine (natural and artificial sand) and 6-63 mm thick (gravel and crushed stone). While the aggregate grain size is large, it is effective in high concrete strength. However, the aggregate with large grain size negatively affects the impermeability of the concrete as well as its imposition; whereas the small grain size increases the impermeability and decreases the strength. Therefore, aggregate sizes in the mixture should be in between certain values. The largest grain diameter of the aggregate to be used in concrete should not be greater than 1/5 of the chamber width, 1/3 of the floor depth and 3/4 of the distance between the two reinforcing bars (Celep and Kumbasar, 2005; Doğangün, 2007).

2.1.4 Additives

They are substances added to the mixture in order to improve the properties of concrete while preparing concrete. Sometimes it is necessary to use additives for reasons such as the building's environment, weather conditions, construction time. There are many different additives. These additives can be listed according to their characteristics as follows (Doğangün, 2007):

- Hardening accelerator additives
- Hardening retarding additives
- Air entraining additives
- Additives to increase impermeability
- Additives to increase workability
- Additives to protect from corrosion
- Additives to increase compressive strength

2.1.5 Mixture

After the cement is mixed with water, the paste formed solidifies over time. When this event occurs inside the concrete, the concrete hardens and gains strength. The most wanted important feature of concrete is its high strength. There are many factors that are effective in the strength of concrete. These are properties such as impermeability, low water cement ratio, optimum aggregate distribution, high quality cement, and tightness of concrete. Furthermore, the concrete mixture should have an optimum consistency in terms of strength, economy and workability. The consistency of concrete can be determined by various methods. The commonly used method in our country is the “slump test” (Figure 2.1). In this experiment, the mixed concrete is filled by compacting with 25 strokes each time, which are shot in 3 stages and a 60 cm long rod with a diameter of 12 mm to a cut cone with a height of 300 mm and a top-diameter of 100 mm, a bottom-diameter of 200 mm. After three minutes, the cone is removed and the slump of the concrete according to the upper point of the cone is measured. This collapse is expected to be between 20-100 mm for concrete to be used in building elements. If the concrete is placed with a vibrator and a waterproof formwork is used, concrete with a stiffer consistency can be used. In this case, it is recommended that the slump remains between 0-50 mm. Less slump generally corresponds to the low water / cement ratio and high concrete strength (Ersoy and Özcebe, 2001; Celep and Kumbasar, 2005).

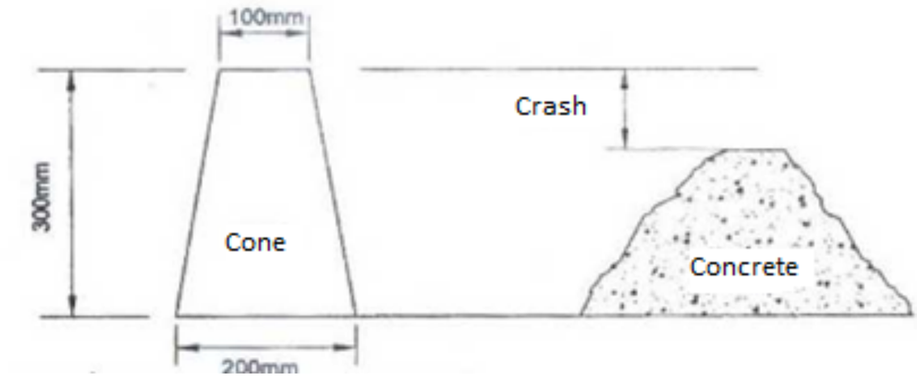

Figure 2.1. Slump Test

The amount of cement (in weight) in the composition of 1 m concrete is called "dosage". The dosage of concretes used in reinforced concrete generally varies between 250-400 kg / m. The high cement dosage does not mean that the concrete strength is high too. The most important parameter contributing to concrete strength is the water / cement ratio (Ersoy and Özcebe, 2001). By keeping the dosage of a concrete constant, different strengths can be obtained by using different water / cement ratios (Figure 2.1). Increasing the water / cement ratio more than necessary will lead to the formation of shrinkage and cracks in concrete, obtaining hollow concrete, a remarkable decrease in strength and weakening of concrete-reinforcement clamping (Doğangün, 2007).

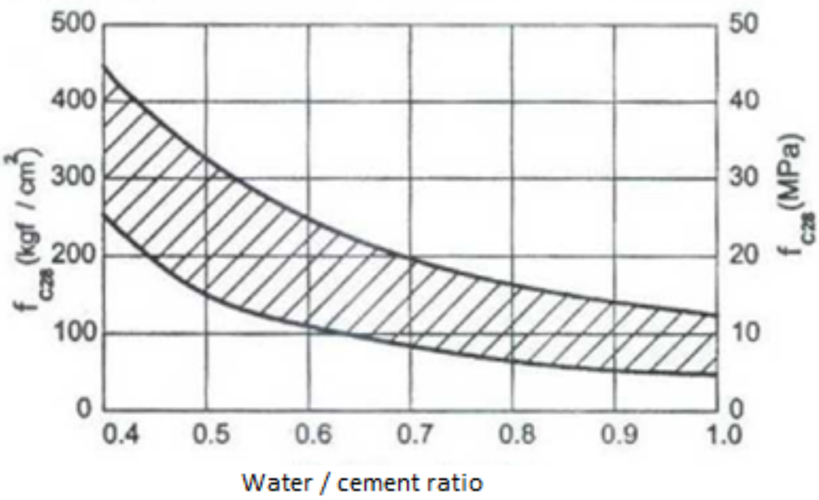

Figure 2.2. Change of Compressive Strength According to Water / Cement Ratio

2.2 Ready Mixed Concrete

It is seen that the production and consumption of ready mixed concrete extends until 1903. In 1998, it is seen that it is produced in Europe and USA with 623 million m^3. Increasing needs such as housing and health with the increase in population has brought up the infrastructure needs in the urban context. Therefore, it made it necessary to build structures such as housing, school, workplace, hospital, road, dam and bridge. Concrete has been applied in order to make the mentioned structures both qualified and continuous (Kafalı, 2004).

Turkey is in the process of economic development and population of a country is increasing with each passing day. Population growth also brings the need for housing. The entry of Turkey to the ready-mixed concrete industry is known as 1976 (Karakul et al., 2005).

In order to increase the quality level in the ready mixed concrete sector, THBB(Turkish Ready Mixed Concrete Association) has introduced some membership criteria. Among them (Karakule et al. 2005);

- The condition to be included in the Quality Assurance System system,
- The condition of having TSİ (Turkish Standards Institution) certificate,
- Having equipments that meet specified standards,
- Existence of A1 and B1 type laboratories in order to perform necessary experiments in ready-mixed concrete facilities,
- The production personnel must receive a certificate by participating in the trainings of TRMCA (Turkish Ready Mixed Concrete Association),
- The mentioned facilities include adherence to environmental control, occupational health and safety checklists.

Table 2.1 Ready-mixed concrete production in Turkey by years is shown.

Table 2.1. Ready-Mixed Concrete Production İn Turkey By Years (http://www.thbb.org/media/374133/thbb-istatistikler-2018.pdf)

1988	1.500.000
1993	10.000.000
1998	26.542.905
2003	26.828.500
2005	46.300.000
2006	70.732.631
2007	74.359.847
2008	69.600.000
2009	66.430.000
2010	79.680.000
2011	90.450.000
2012	93.050.000
2013	102.000.000
2014	107.000.000
2015	107.000.000
2016	109.000.000
2017	115.000.000
2018	100.000.000

2.2.1 General Investigation of Ready-Mixed Concrete Sector

When examining the ready mixed concrete industry in general come into question, both components, classification and its place of both in the historical process in Turkey and the world is important.

2.2.1.1 Definition and Production of Ready-Mixed Concrete

Ready-mixed concrete; It is a building material produced in plants called concrete plants by transferring the mixing ratios of water, aggregate, cement and additives, previously prepared recipe, to computer systems. The fact that ready mixed concrete is produced by prescription and computer automation programs ensures that concrete is produced in accordance with quality and standards. The concrete produced in the ready mixed concrete plant is in the form of semi-finished products. Semi-finished concrete is sent to the construction site to be cast with the help of special tools called truckmixers (Figure 2.3). Depending on the area to be cast on the construction site, it is poured directly from the container of the truckmixer or with the help of construction machines called concrete pump (Figure 2.4).

Figure 2.3. Concrete Pump

Figure 2.4. Truckmixer

2.2.2 Components of Ready-Mixed Concrete

When the components of ready mixed concrete are examined, it contains the materials in volume as follows (Demiryürek, 2007);

- % 75 aggregate
- % 15 water,
- % 10 cement.
- If necessary, up to 2% of the cement weight can be added.

The aggregate deposits are shown in Figure 2.5 (Milli Eğitim Bakanlığı, 2015).

Figure 2.5. Aggregate Deposits

The general name of gravel, stone, sand and similar inorganic materials is called aggregate. The presence of some properties is preferred in aggregates. Among them (Nallı, 2006);

- Not having small grains,
- High purity rate,

- Having a firm and durable structure,
- Not having long and flat grains,
- No harmful reaction must occur when combined with cement,
- Having strength can be said.

When the mixed water that forms the ready mixed concrete is examined, it should be of a clean and drinkable type that does not have a pH value less than 7. In addition, it should not contain chemicals that would damage the concrete.

The least volume of substance in the ready mixed concrete mixture is cement. It is also one of the most important items. Cement used in ready mixed concrete must be in TS EN 197-1 standards (Türk Standartları Enstitüsü, 2012).

2.2.3 Classification of Ready-Mixed Concrete

When the classification of ready mixed concrete is desired to be done in a sectoral sense according to State Planning Organization (Kafalı, 2004);

- Manufacturing Industry,
- Terra-cotta (Baked clay),
- Cement materials are the determining factors.

2.2.4 History of Ready Mixed Concrete, Ready Mixed Concrete Sector in the World and Turkey

2.2.4.1 History of Ready-Mixed Concrete Industry

It is known that ready mixed concrete production came to the agenda in Germany in 1903 and in the USA in 1913; then many ready-mixed concrete companies were established after the war (Demir, 2010).

When it is in demand to examine the evolution of ready mixed concrete, it makes sense to examine the relationship between compressive strength and water/cement. Figre 2.6 shows the relationship between compressive strength and water/cement in the evolution of ready mixed concrete (Demir, 2010).

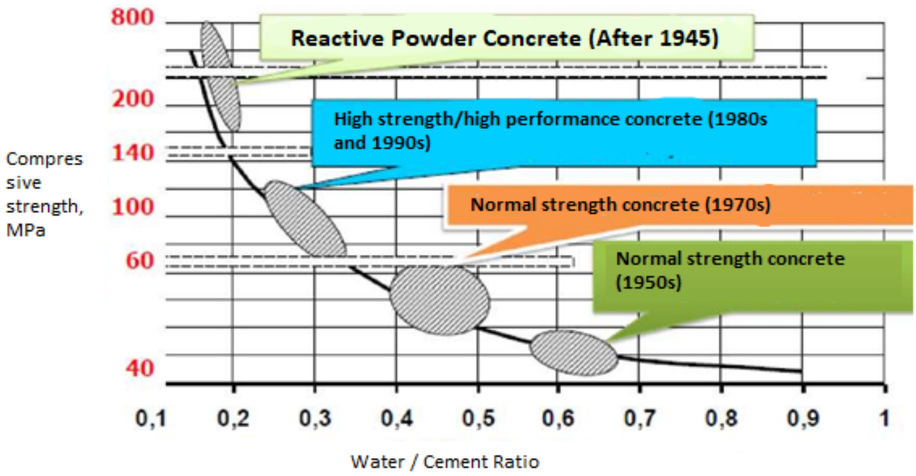

Figure 2.6. Relationship between Compressive Strength and Water/Cement in the Evolution of Ready-Mixed Concrete

Table 2.2 shows the years of entry of some countries into the ready mixed concrete sector.

Table 2.2. Years of Entry into the Ready Mixed Concrete Sector of Some Countries (http://www.thbb.org/media/374133/thbb-istatistikler-2018.pdf)

Germany	1903
Britain	1930
France	1933
Spain	1942
Netherlands	1948
Belgium	1956
Austria	1961
Italy	1962
Israel	1963
Turkey	1976

As seen in Table 2.2, among the top ten countries in the ready mixed concrete sector, starting with Germany in 1903 is Turkey the tenth country entered the sector in 1976. Table 2.3 shows the history of the ready mixed concrete industry (History of Ready-Mixed Concrete Industry, 2020).

Table 2.3. History of Ready-Mixed Concrete Industry

It started in 1824 with the production of Modern Portland Cement.
The first reinforced concrete structure was built in 1857.
In 1914, a truckmixer vehicle was developed in the USA in order to transport concrete.
Concrete Grout Delivery Pump was developed in 1927.
After the war, using and producing ready mixed concrete in many countries became a matter of discussion.
With the acceleration of urbanization and construction in the second half of the 20th century, the use of concrete and the technological developments in this field have increased.
By the late 1970s, some construction companies have started producing in Turkey and to use it for themselves.
Starting from the second half of the 1980s, the ready-mixed concrete industry has been literally started.

2.2.4.2 Ready Mixed Concrete Industry in Turkey

In the case of scrutinizing the ready-mixed concrete sector in Turkey is to be taken effect, it is important to analyze the size of the sector. When it is desired to examine the production values from 2009 to 2014;

Production values are shown in Table 2.4 (Göksel, 2016).

Table 2.4. Production Values
(http://www.thbb.org/media/374133/thbb-istatistikler-2018.pdf)

Years	Ready-Mixed Concrete	Construction	Cement	% Share of Ready-Mixed Concrete in Construction
2013	4.296.514.241	95.372.181.443	6.197.738.764	4,5%
2014	5.961.062.923	115.557.445.741	6.648.818.405	5,2%
2015	7.969.985.106	156.368.558.393	8.188.265.637	5,1%
2016	8.401.077.674	184.219.489.622	8.824.082.734	4,6%
2017	10.928.899.281	220.915.711.989	11.586.543.098	4,9%
2018	13.259.981.269	262.795.501.272	11.751.892.265	5,0%

- The share of ready mixed concrete in construction sector increased from 4.5% in 2009 to 5.0% in 2014. It can be seen that the decrease in percentage (%) value was experienced in 2011 and 2012.

- It is witnessed that Ready-Mixed Concrete production values have increased every year from 2009 to 2014 and have not decreased at all.

When ready mixed concrete sector in Turkey is analyzed, another important issue is the number of the company come to existence and the production facilities by years. The number of ready-mixed concrete companies and production facility in Turkey by years is shown in Table 2.5.

Table 2.5. Number of Ready Mixed Concrete Company and Production Facility in Turkey by Years (http://www.thbb.org/media/374133/thbb-istatistikler-2018.pdf)

NUMBER OF READY MIXED CONCRETE COMPANY AND PRODUCTION FACILITY IN TURKEY BY YEARS		
	Number of Ready Mixed Concrete	Number of Production Facility
1988	25	30
1993	70	110
1998	166	341
2003	238	429
2005	277	568
2006	409	718
2007	477	845
2008	462	825
2009	467	845
2010	500	900
2011	520	945
2012	540	980
2013	580	1040
2014	580	1040
2015	621	1098
2016	570	1120
2017	540	1184
2018	495	1100

According to Table 2.5, number of ready-mixed concrete companies and facilities in Turkey from 1988 to 2016 are examined. According to the table;

- In 2013 and 2014, the number of ready-mixed concrete companies and the number of firms are the same.

2.2.4.3 Ready Mixed Concrete Industry in the World

When it is desired to analyze the ready mixed concrete industry in the world, it will be reasonable to analyze the ready mixed concrete production in the world and in the member countries of the European Ready Mixed Concrete Organization on the basis of years. Table 2.6 shows the production of ready-mixed concrete by years in the world and in the member countries of the European Ready Mixed Concrete Organization.

Table 2.6. Ready Mixed Concrete Production by Years in the World and European Ready-Mixed Concrete Organization Member Countries (https://www.Thbb.Org/Media/290192/Thbb-%C4%B0statistikler-2017.Pdf; http://www.thbb.org/media/374133/thbb-istatistikler-2018.pdf)

READY-MIXED CONCRETE PRODUCTION BY THE YEARS IN THE WORLD AND EUROPEAN READY-MIXED CONCRETE ORGANIZATION MEMBER COUNTRIES (ERMCO) (million m^3)					
COUNTRIES	2014	2015	2016	2017	2018
Austria	10,0	10,5	10,8	11,0	11,8
Belgium	12,3	12,3	12,5	12,7	12,8
Czech Republic	6,5	6,5	6,8	6,8	7,1
Denmark	2,3	2,5	2,5	2,6	2,6
Finland	2,6	2,6	2,9	3,0	2,8
France	36,4	34,8	36,1	38,7	39,7
Germany	46,8	47,2	49,5	51,7	52,8
Ireland	2,4	3,5	4,2	4,3	4,3
Italy	28,0	25,3	23,3	27,3	27,3
Netherlands	6,5	6,3	6,5	6,9	7,5
Poland	19,2	19,8	20,4	20,4	25,1
Portugal	2,8	2,8	3,5	3,7	4,5
Slovakia	1,6	1,9	1,9	2,4	3,0
Spain	15,9	16,3	16,3	16,3	22,2
Sweden	4,0	4,1	4,5	4,5	4,5
Britain	22,7	23,7	24,6	22,9	22,5
Total of European Union	220,0	220,0	226,2	235,2	250,4
Average of European Union	13,8	13,8	14,1	14,7	
Israel	14,0	15,6	15,4	16,9	18,0
Norway	3,8	3,7	4,0	4,1	4,1
Switzerland	12,0	12,0	11,5	11,5	10,9
Turkey	107,0	107,0	109,0	115	100,0
Total of ERMCO	356,8	358,3	366,1	382,5	383,4
Russia	40,0	40,5	37,0	35,0	38,0
USA	230,0	260,0	265,0	270,0	274,0
Japan	88,0	84,0	84,0	84,0	84,8

USA is the country with the highest ready-mixed concrete production in 2014-2015-2016.

- Slovakia is the country with the lowest ready-mixed concrete production in 2014-2015-2016.

2.2.5 Ready-mixed Concrete Production Facilities

Production of ready mixed concrete involves pouring, handling and the production process. When the concrete plant, which plays a key role in ready mixed concrete production, is examined, according to the storage types (Akboğa, 2011); there are

- Hopper type,
- Star type.

2.2.6 Ready Mixed Concrete Plant

The facilities where ready-mixed concrete is produced are called ready-mixed concrete plants. In these facilities, ready-mixed concrete is produced in mixer machines and filled into truck mixers. What can be found in general a ready mixed concrete plant is as follows (Figure 2.6).

- Cement silos
- Mixer (single shaft, twin shaft, pan mixer)
- Plant operation room
- Laboratory
- Weighing belts
- Mixer feeding belt
- Bunkers
- Chemical additive tanks
- Settling pits
- Transformer and electrical panels

- Hydrophore unit
- Compressor unit and air tank
- Truck mixers
- Concrete pumps

Other buildings.

In addition to the tools mentioned above, in different concrete plants, according to the production method and design, the front-loading band, recycling unit, water cooling unit, front loading pit, etc. can be found.

Apart from the sections listed in ready mixed concrete plants, a repair workshop can be found for maintenance and repair activities. In addition to tools and units, maintenance and repair of the plant can also be carried out in these workshops. There is a small workshop in the ready mixed concrete plant examined in this study, but tool maintenance is not allowed in the workshop.

Another unit that can be encountered in ready mixed concrete plants is the fuel unit. In the fuel unit, which is not available in every plant, the diesel fuel needs of truck mixers and concrete pumps can be supplied. There is a fuel unit in ready-mixed concrete plants examined in this study. Dangers and risks in the fuel unit and precautions that must be taken are presented in Annex 2.

Figure 2.7. Ready-Mixed Concrete Plant

Workstream in ready mixed concrete plants is described in Figure 2.7. The materials are loaded into the aggregate bunker with the help of a conveyor belt or work machine according to the structure of the plant. The aggregate loaded is weighed in the amount determined by the automation program in the weighing band (Quality group prepares the concrete formula called recipe and adds it to the automation program). The weighed aggregate enters into the mixer with the help of a conveyor belt. Another component of ready mixed concrete which is cement also must be put into the mixer in the amount determined by the automation program. The pneumatic valve between the cement silo and the mixer opens and the amount of cement determined by the automation program enters the mixer. Water, which is the last component of concrete, enters the mixer like cement by opening the pneumatic valve and therein, all components are mixed in the mixer.

Additive is added to ready mixed concrete according to the recipe. The additives added might cause the concrete to set faster or slower. It is also effective in adjusting the consistency of the concrete.

Ready mixed concrete produced by mixing in the mixer is filled into the truck mixers with the help of the filling funnel. Concrete is sent to construction sites by truck mixers. In construction sites, concrete is poured directly with truck mixers or with the help of a concrete pump.

The tubs of the truck mixers that return to the plant after pouring are washed. The syrup (mixed with water and cement) released as a result of washing the tub is poured into the settling pit.

2.3 Chemical Additives Used in Ready-Mixed Concrete

More fluidity is required in building reinforcement projects, in frequently reinforced structural elements, in productions where vibration application is not possible, in narrow sectioned complex formwork systems, in precast productions, in architectural productions with a gross or aesthetic patterned surface requirement.

2.3.1 Concrete Fluidity Requirement and Chemical Admixtures

Chemical additives with different composition are prepared in the construction industry in line with the requirements and offered to the consumer. In general, the most commonly used chemical additives are plasticizing additives that increase the workability of concrete (Erdoğdu, 2000). Chemical additives are defined in the TS EN 206-1 (2002) standard as a material added to the concrete in a small amount compared to the cement mass during the mixing process in order to change some properties of fresh or hardened concrete. Moreover, according to the TS EN 934-2 (2002) standard, concrete chemical additive is defined as the substance added to the concrete in order to change the fresh or hardened properties of the concrete during the mixing process must not exceed 5% of the cement mass.

Although it is estimated that chemical additive research is simultaneous with the use of binder in building technology, it is known that the study on the first chemical additives was carried out by Abrams in 1924. Abrams, one of the famous founders of concrete technology, thinks that calcium chloride is a chemical additive that accelerates setting and hardening. However, nowadays, manufacturing companies use the expression chlorine-free when promoting their products (Akman and Akçay, 2005).

In the early years of 20th century, it has been stated by many researchers that the factor affecting workability and strength in concrete studies is the water-cement ratio. However, the strength of the concrete in other words the durability, was not taken into consideration. The water-cement ratio creates a contradictory situation between the properties of workability and durability. When the water increases, the processability increases but the durability decreases. The solution is not economical since it is necessary to increase the cement so that the durability does not decrease. The need to find a solution to this contradiction was the reason for plasticizing additives to come to existence.

The first materials used as a plasticizer were natural resins, oils such as tall oil from wood resins, and sulfone soaps. As a result of these studies, sodium or calcium lignosulfonate (LS) produced by sulfonation of lignin liqueur obtained from paper production was begun. LSs are made up of a natural macromolecule and with their SO_4 - tip, they have a hydrophobic property and prevent the agglomeration by sticking to the cement grains. It also has air entraining features. Since LS contain sugar, they also have hardening retarding feature. With these features, they have been the only additives used for many years. The sulfone group in its structures was added to the content of other additives as a necessary structure in the following times. Enhancing the resistance to freezing and thawing of concretes by LS entrained concretes, which has led to further research in this area. The air bubbles formed are small in size and homogeneous, preserving their own continuity. Vinsol resin (sodium abietate) derive from fir resin provides these properties. However, air entraining additives include LSs, alkyl cracking product, alkyl acid sulfonates and ethanolamines (such as triethanolamine). Air entraining additives are considered and studied as a separate class among concrete additives. Chemical concrete additives have been researched and produced to provide other expectations (Akman, 2005).

Chemical concrete additives, which are indispensable for the concrete technology pf today, are additives we call super plasticizer (SP) and hyper plasticizer (HP). Owing to these, “High Performance Concretes” (HPC) can be produced by increasing the concrete resistance 3-4 times. The workability-durability contradiction has been resolved thanks to these additives. Water-Cement ratio below 0.30, self-settling concrete without the need for a vibrator and concrete with high durability even against the 70 MPa can be produced. The greatest development in the field of chemical additives has been achieved through the production and implementation of these additives. Naphthalene Sulphonate Formaldehyde (NSF) polycondensation, which belongs to the superplasticizer (SP) group, was found in 1938. However, since it was very expensive compared to Lignosulfates (LS) back then, it was not applied until 1970s. The first person who practiced it was the Japanese chemist Hattori. In the same years, Aignesberger and his team fabricated the Melamine Sulfonate Formaldehyde (MSF) polycondensation in Germany. These polyelectrolyte additives are produced in four stages; The first stage is naphthalene sulfonation, the second stage is its composition with formaldehyde, the third stage is neutralization, and the fourth stage is filtration. Although Naphthalene and Melamine based SAs have a large place in the market, LSs have been upgraded to SA level by making changes in their structures. After the Naphthalene, Melamine-based additives and Modified LS, which are described as the second-generation SA, Polycarboxylate (PC) polymers called third generation SAs and especially polyacrylates started to be produced. In these, a comb-shaped structure is formed with polyethylene or polyether radicals grafted into the main molecules and then the molecule gradually starts to cover a larger volume (Akman, 2005). In the 2nd generation SA, the dispersion of cement grains is due to the electrical repulsion of the ions on their surface, whereas in the 3rd generation this dispersion occurs due to the numerical structure of the attached molecules. Sulphine stuffs are also added to these and contribute to electrical repulsion. The dispersion power of the 3rd generation SAs is very high. Therefore, the water-cement ratios are even lower and they allow self-compacting HPC production.

2.3.1.1 Types And Properties Of Chemical Additives

The use of chemical additives in concrete is generally intended to improve one or more properties of fresh and hardened concrete. Improvements in fresh concrete properties with the use of chemical additives (Erdoğan, 1997):

- Increasing the workability without increasing the amount of water,
- Reducing the water requirement for a certain workability,
- To extend or shorten the hardening time,
- Preventing removal of water,
- Decreasing segregation,
- Improving pumpability,
- Reducing the rate of texture loss.

Improvements to hardened concrete using chemical additives (Erdoğan, 1997):

- To reduce or delay hydration temperature impetuously,
- Increasing the durability and speeding up the durability development at an early stage,
- Improving many other mechanical properties of concrete,
- Increasing durability to harmful environmental effects,
- Controlling alkali-aggregate reaction and reducing permeability,
- Strengthening the reinforcement-concrete bond and preventing its corrosion,
- Financing.

There are many concrete chemical additives with different compositions and functions in the literature (Akman, 1996). According to TS EN 934-2 (2002), these contributions are given in Table 2.7.

Table 2.7. Concrete Chemical Additives (TS EN 934-2, 2002)

Chemical Additive Type	Performance Requirement	Value in TS EN 934-2
Water reducer / plasticizer	Equal consistency water reduction	Reduction> 5%
Highly water reducer / super plasticizing additives	Equal consistency water reduction. Increased consistency in equal water-cement ratio	Decrease> 12% Collapse Increase> 120mm
Water reductive additive	Decreased water reduction	Decrease> 50%
Waterproofing additive	Decreased capillary absorption	Decrease by mass> 50%
Air-entraining additive	Air gap in hardened concrete	Aperture factor <0.200pm
Set accelerating additive	Decrease in initial setting time	Decrease> 40% at 5°C
Hardening accelerator additive	Compressive strength on day 1 Compressive strength on day 2	Increase> 20% at $20^{o}C$ Increase> 30% at $5^{0}C$
Retarding additive	Increase in initial setting time and final set time	Setting increase> 90 minutes Final set increase <360 minutes
Retarder / water reducer / plasticizer additives	Reduction of water in equal consistency Increase in initial setting time and final set time	Decrease> 5% Setting increase> 90 minutes Final set increase <360 minutes
Retarder / highly water reducer / super plasticizing additives	Reduction of water in equal consistency, consistency increase in equal water / cement ratio, increase in initial setting time and final set time	Decrease> 12% Collapse increase> 120mm Setting increase> 90 Final set increase <360 minutes
Set accelerator / water reducer / plasticizer	Reduction of water in equal	Decrease> 5% Decrease> 30% at $20^{o}C$ and Decrease> 40% at $5^{o}C$

The main functions of the additives in the TS EN 934-2 (2002) standard can be summarized in 4 groups:

1. Water reduction in high or normal amounts,
2. Delaying hardening,
3. Accelerating hardening,
4. Air entrainment.

There are also those who can provide several of these functions at once (Erdoğan and Erdoğan, 2007). One of the usage areas of SAs is high durability concrete production. SA's are divided into 3 groups as modified lignosulfonates (MLS), sodium naphthalene (or melamine) sulfonate formaldehyde polycondensates (NSF or MSF) and polycarboxylate (or hydroxy carboxylate) salts (PC). PCs have superior properties than other plasticizers even with less water usage such as higher water reduction and more fluidity. In the first and second group of SAs, due to the loading of cement grain surfaces with the same negative charge, dispersion is achieved by pushing the grains together. In PCs, stearic barrier caused by the size and numerical structure of molecules is more effective in realizing the dispersion (Yıldırım and Uyan, 2005). Concretes with a settling of more than 19 cm are known as "fluid concretes" (ASTM C 1017, 1994). These concretes provide important advantages in casting of narrow section and / or frequently reinforced structural members in order to provide sufficient compaction where vibration cannot be performed.

2.3.1.2 Zeta Potential

The solution formed by the dispersion of a substance in a non-solvent medium in dimensions of 10- - 10- cm is called a colloidal solution. Cement, water, aggregate and chemical additive mixture that affect the dispersion of this system is a colloidal solution. The electrical charge on the surface of colloidal particles (cement, aggregate, etc.) occur as a result of many different mechanisms that involve the separation of acidic or basic groups on the surface of the particle or the adhesion of a charged group. The layer formed by the coating of the particle surface with the diffuse layer of opposite charged ions is called an electrical double layer. The electrical double layer explains the electrical potential change near a surface and gives very important information about the behavior of colloidal particles and other particles (fluidizing additive, surfactants, etc.) in contact with the solution (İKSA, 2012).

One of the methods used in studies to determine the cement-chemical additive compatibility is zeta potential measurements. Cement particles and other very small and thin grains have a surface charge in mixtures called suspension. Zeta potential is the push or pull value measurement between grains. Zeta potential measurement gives detailed information about dispersion mechanisms and is the key to electrostatic dispersion control. The grain in a certain charge attracts the ions with the counter charge in the suspension. As a result, a strong bond surface is formed on the surface of the charged grain, and then a cloud of ion spreads outward from the surface of the charged grain. This dispersed ion cloud contains a boundary called the "sliding surface". The part of the charged grain and the ions around it up to the sliding surface border acts as a single piece. The potential on this sliding surface is called the zeta potential and is affected by both the surface structure of the grain and the content of the liquid it is in. Not the electric charge on their surface but the zeta potential values determine the behavior of the grains in polar fluids (İKSA, 2012).

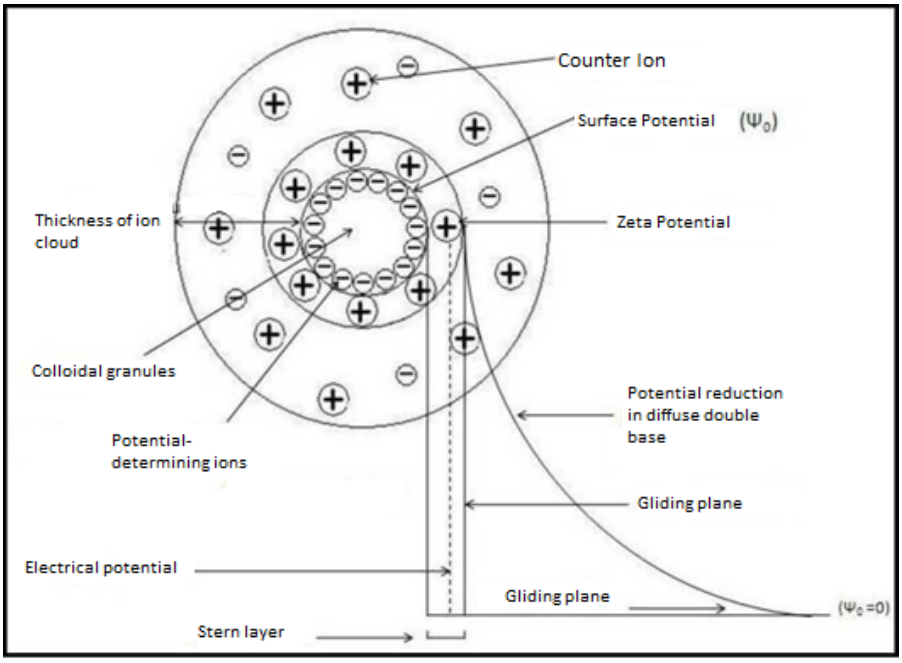

Figure 2.8. Coagulation of Cement Paste
(http://www.iksa.com.tr/pdf/zeta.pdf)

When cement, aggregate, clay etc. placed in the water environment, even if there are no other ions in the water, the solid surface acquires a positive or negative electrical charge due to the "H + and OH" ions detaching from the solid material to the water. Therefore, the water in environment becomes of a solution containing various ions. In this case, according to the coulomb law, ions with opposite charges pull each other and are attracted by the mineral surface. Thus, while the concentration of some of the ions in the solution increases around the solid surface, some of them decrease. Oppositely marked ions muster near the surface and try to balance the surface electric charge. These ions collected near the surface, that is on the solid-liquid interface, are called counters ions. Often ions attach to the colloidal particle surface by electrostatic gravitational forces. This ensures that a surface charge or surface potential is formed on the first holding layer. This surface charge can cause a repulsion force between the two particles approaching each other and the counter ions to be attracted by the colloidal particle. Zeta potential measurement is an easy and effective parameter for defining, understanding and controlling this size behavior model. The most important reason for determining the zeta potential value is to determine the size of the diffuse double layer around the particle. The zeta potential allows to understand and control many important properties of colloidal systems and to determine the electrical charge or potential on the particles. It is also very important for understanding dispersion and aggregate processes. The value of the zeta potential prevents the formation of aggregates, making colloidal suspensions stable. The zeta potential is related to surface charge density and double layer thickness. The surface charge density depends on the concentration of potential determining ions. Since the H + ion is the potential determining ion in many systems, the zeta potential depends on pH. Zeta potential value is positive for low pH values and negative for high pH values (IKSA, 2012).

2.3.1.3 Chemical Additive And Cement Compatibility

According to the TS EN 934-2 (2002) standard, additives that do not provide at least 10% water reduction are considered to be incompatible. Incompatibility might occur in fresh concrete and hardened concrete. In HPCs produced with very low water content, the most important problem in the fresh state is to ensure the workability and protection. This depends on the adhesion capacity of the SA molecules. The presence of SA and lack of water cause the hydration products to be different and internal structure morphology to change. As a result of these changes, setting and hardening times, hydration heat value and speed differ and the desired level of durability cannot be reached. All these problems arise from the ratios of the C_3A, C_4AF contents of cement, the types and amounts of alkali salts dissolved, the type and ratio of sulfates added to clinker.

The alkali problem in cement has been the subject of many intensive studies. These studies, which are handled for the normal concretes, have also started to be carried out for SA participation and HPCs. The use of PC additives, which provide high strength with low water-cement ratio, has enabled obtaining fluid, self-settling concretes. However, the compatibility of SAs with cement, workability, durability, hardening, hydration heat, temperature, and autogenous shrinkage also caused some problems. These are due to reasons which are not highlighted in the standards of the cement related to the amount of alkali dissolved, calcium sulfate amount, C_3A structure and composition of SAs, molecule types and weights, participation rates. These fall under the examination field of chemists. Civil engineers take precautions only with simple experiments and observations (Akman and Akçay, 2005).

The additives might remain free, as solid or solution, interact with the cement surface, combine with cement paste or cement components. Type and size of the interaction may affect the physio-chemical and mechanical properties of concrete such as water requirement, hydration heat, composition of the hydration products formed, hardening time, microstructure and durability (Ramachandran, 1995).

According to Jiang et al. (1999), among the factors affecting the quality and properties of concrete, the fluidity of cement paste has an important role. Better fluidity can be achieved by using a superplasticizer additive. Therefore, the importance of superplasticizers in concrete technology is increasing day by day. However, the initial high workability of high-performance concretes with low water-cement ratios produced using superplasticizer chemical additives may soon be lost, meaning loss of rapid collapse. This is attributed to the rheological incompatibility of the superplasticizer with cement (Ramyar, 2008).

Huynh (1996) stated that the rheology of high-performance concrete with superplasticizer additives is affected by many parameters related to cement, superplasticizer or their interaction (Jiang et al, 1999). These are:

- Chemical and phase composition of cement, especially C_3A and alkali content,
- The fineness of cement,
- Type and the amount of calcium sulfate in cement,
- Chemical structure and average molecular weight of the superplasticizer,
- The degree of sulfonation and (+) ion structure of the superplasticizer,
- Dosage of the superplasticizer and addition method to the mixture.

According to Ramachandran (1995), high workability mixtures that the superplasticizer has been added to will lose their properties after 30 to 60 minutes. The factors that affect the loss of collapse include the initial collapse value, the type and amount of the superplasticizer and cement, the time of addition of the superplasticizer, the temperature, humidity, the mixing procedure and the interaction of other additives in the mixture. It reacts with C_3A gypsum in the timeframe when the loss of collapse occurs. The hydration products formed develop in crystal structure. The amount of reaction between C_3A and gypsum and the crystal structure of hydration products can have a significant impact on workability. This delayed mechanism can ensure that the additive maintains the collapse value of concrete for a long time. In general, plasticizing additives increase the hardening time. This situation was explained by the decrease in the rate of hydration in the first hours in the presence of additives (Ramyar et al. 2008). This indicates that some chemical additives that do not dissolve in water creates a plasticizing effect in the alkaline environment resulting from cement hydration.

Puertas et al. (2012) examined the effects of mineral additives such as limestone, fly ash and silica fume in cement and the interaction of these additives with NSF, MSF, MLS and PCE additives. The adhesion isotherms of mineral mixed cements have zeta potentials and compared with those of unmixed cements. The results indicated that mineral additives changed the physical (specific surface) and chemical (superficial load) characteristics in cement-SA compatibility. It is stated that the addition of mineral additives to Portland Cement reduces the clinker requirement in cement production and increases the ecological efficiency of it. It is also reported that mineral additives can positively affect rheology and cement-SA interaction.

According to Ramyar et al. (2005), increasing the cement dosage in concretes has increased workability. This increase was particularly high when using naphthalene and polycarboxylate based chemical additives. It is stated that this situation will indicate that the water cutting capacity will be higher as cement dosage increases if naphthalene and polycarboxylate based additives are used. In addition to cement fineness and total alkali amount, there are other factors affecting the collapse values. Since the cement absorbed additive with high C_3A / SO_3 (C_3A + C_4AF) % value is high, it is stated that the fluidity will be adversely affected and the incompatibility can be attributed due to the decrease in the amount of fluidizer additives required for adequate dispersion of C_3S, C_2S components. In the experiments, the lowest air content values were obtained in concrete with PC SA additives, it was determined that the contribution of the unit volume weight increases as the water reduction ability increases, and the use of chemical additives generally increases the air content (Ramyar et al., 2005).

Ramyar (2007) described the factors affecting cement additive compatibility as cement-based effects, superplasticizer-based effects, SA adhesion to cement, time of addition to the mixture and temperature effect. If the initial high workability of concretes containing SA, especially with low water-cement ratio, disappears after a short time, this has been attributed to the rheological incompatibility of SA and cement (Jiang et. Al., 1999). Chemical composition and fineness of cement, and solubility of sulfates are the most important factors affecting the rheological properties of HPCs. The low C_3A dosage in cement is a desired situation in the system containing SA. In order for the dispersing effect of the SA to be effective, it should hold on to the C_3S and C_2S components. In cements with high C_3A + C_4AF dosage, the amount of adherence to C_3S + C_2S components, that is, the viscosity of the paste decreases due to the adhesion of the additive to these components (Chandra et al., 2002).

As the cement fineness increases, the amount of water it requires increases, and if the amount of water is fixed, its viscosity (consistency) increases. The amount of additive to be used for the same consistency also increases. It is also known that the fineness of cement increases hydration rate. Cements with relatively lower C3A dosage and low fineness are also known to show good fluidity. The more global the cement particles are, the more fluid they are. The type of calcium sulfate (gypsum, etc.) added as a stabilizer in cement production affects the viscosity of the mixture. Basically, it has been reported that the effect of sulfates on rheology depends on the dissolution rate of SO_4 ions rather than the amount of SO_3 in the system. It has been reported that the workability of mixtures containing superplasticizer with decreasing alkali content of cement increases. The additives added to the clinker to grind the cement change the adhesion of the SAs to the cement and therefore the workability. Features such as the position of the bound sulfonate group, the length of the polymer chain and their crosslinking, the amount of residual sulfate and the type of counter ion used in the neutralization process determine the effectiveness of SA. The adhesion of SA on cement and the effectiveness of the additive depends on its concentration in the solution. The adhesion of the additive to the cement grains is significantly affected by the alkali content of the cement. The fact that these alkalis are water soluble or depend on the main components can have different effects. In recent studies, it has been reported that the dispersion process has been carried out with the adhesion of the additive to the hydration products and the additive absorbed by the cement components is not capable of dispersing. Increasing temperature decreases fluidity and increases collapse loss (Nakajima et al., 2004).

According to Golaszewski (2012), the main objective of SAs is to prevent coagulation of cement paste and increase the amount of free water in the mixture.

By providing high workability in the mixture with low water-cement ratio, they also give the properties preferred in hardened concrete. He divided SAs into 3 groups that are NSF polymers, carboxylic polymers (PC) and carboxylic ethers (PCE). He reported that the C_3A content, cement specific surface area and Na_2O equivalent of cement are important, but SO_3 content is not important in cement. In general, the cement specific surface area indicates that the performance of SA decreases as the C_3A and Na_2O equivalent increases. He reported that the C_3S content of cement as the rheological constants increase the threshold shear stress intensely, while the plastic viscosity decreases slightly. He reports that PC and PCE performance decreases as Na_2O equivalent increases in cement content. He stated that determining the rheological coefficient of cement can be effective in determining the compatibility of PC, PCE and SA and thus in cement selection.

As a result of their studies, Puertas et al. (2012) stated that the rheological behavior of cements containing additives depends on the physical (specific surface area) and chemical (surface charge and reactivity) properties of the mineral additive used, and these properties are affected by the presence of superplasticizers. They reported that limestone additive has a strong affinity for the adhesion of polymer molecules to the surface of the polymer molecules, it is more suitable for the intense adhesion of PCE additives compared to other investigated additives, and the decrease achieved in shear threshold stress value in the presence of NSE and PCE was the highest. They reported that fly ash showed more attraction than other cements and mineral additives investigated for MSF and NSF. In the case of silica fume, they reported that the physical feature is dominant due to its high negative zeta potential (~ 16 mV), and that it requires high dosage of SA to improve the rheological behavior of CEM II / A-D fresh pastes due to its high specific surface area.

Puertas et al. (2012) reported that while conventional chemical additives work with an electrostatic mechanism, PCE-based SAs balance cement and additives with a steric mechanism, fully understanding this effect requires a nanoscale study, PCE decreases the threshold shear stress at lower dosages more than other additives while adhering, NSF was more effective in all type II cements researched in traditional additives, and LS was the weakest in performance.

2.4 Ready Mixed Concrete Design and Chemical Additive Selection

2.4.1 Compressive Strength of Concrete

Concrete is a brittle building material with high compressive strength and low tensile strength. Since the very low tensile strength of concrete is not taken into account in the calculations, the most important feature is the compressive strength. The strength of concrete depends on the age, size and type of loading of the sample. The standard compressive strength of concrete is defined as the resistance of cylindrical samples, which are kept in water for 28 days, 150 mm in diameter, and 300 mm in length, under axial pressure and expressed in terms of tension. Instead of the standard cylinder sample, cube samples of 150X150X150 mm or 200X200X200 mm are also used from time to time (Ersoy and Özcebe, 2001). The compressive strength obtained in this case is different from that obtained with the standard cylinder. Concrete is a material that gains strength over time. It gains strength very quickly in the first 7 days. Later, this increase in strength continues slowly. Strength formed after 28 days is accepted as the standard strength in regulations. The characteristic compressive strength (fck) of concrete is the compressive strength value that is 10% probability that the strength to be found in the samples to be tested may fall below this characteristic compressive strength (Ersoy and Özcebe, 2001). Concretes with characteristic compressive strengths between 16 N / mm and 25 N / mm are characterized as normal-strength concrete, and concrete with higher than 25 N / mm are considered as high-strength concrete. Accepted values of concrete types and strengths in TS500 are given in Table 2.8.

Table 2.8. Types and Strengths of Concrete

Type of Concrete	Characteristic Compressive Strength(fck)	Strength Feature	Equivalent cube compressive strength (150mm)	Characteristic axial tensile strength (fctk)	28 Day Elasticity Module
	MPa		MPa	MPa	MPa
C16	16	Normal Strength Concrete	20	1.4	27000
C18	18		22	1.5	27500
C20	20		25	1.6	28000
C25	25		30	1.8	30000
C30	30	High Strength Concrete	37	1.9	32000
C35	35		45	2.1	33000
C40	40		50	2.2	34000
C45	45		55	2.3	36000
C50	50		60	2.5	37000

2.4.2 Stress-Deformation Relationship of Concrete

Understanding the stress-deformation relationship of concrete is very useful and guiding in both calculation and design stages. Many variables affect the stress-deformation properties of concrete. Due to the effects of these variables, it is impossible to define a single and exact curve for concrete. Since concrete is a material that deformates over time, the o-£ curve is not a linear elastic curve (Ersoy, Özcebe, 2001; Celep and Kumbasar, 2005).

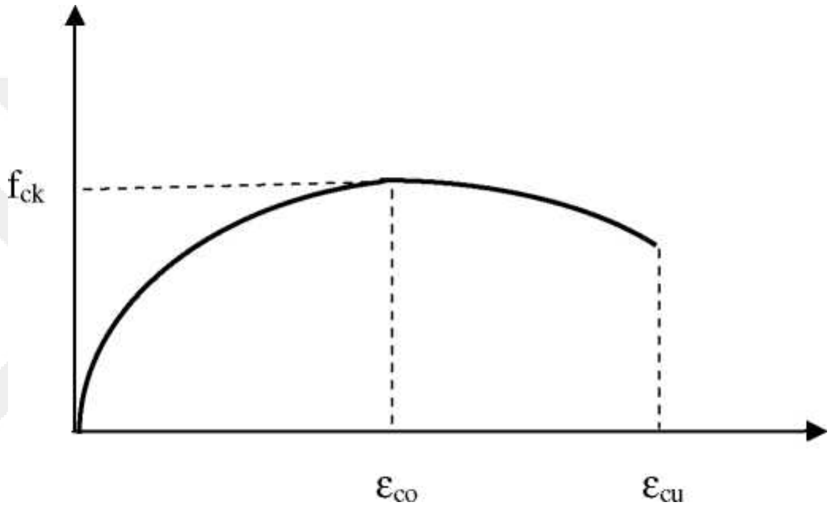

Figure 2.9. o-£ Curve of Concrete

As can be seen in Figure 2.9, the curve follows an almost direct behavior at low stress values. Under the effect of increasing loads, linearity disappears and the curve starts to resemble parabola. Strain continues even though the stress decreases after the peak point showing the compressive strength. However, this curve does not apply to very slow loads.

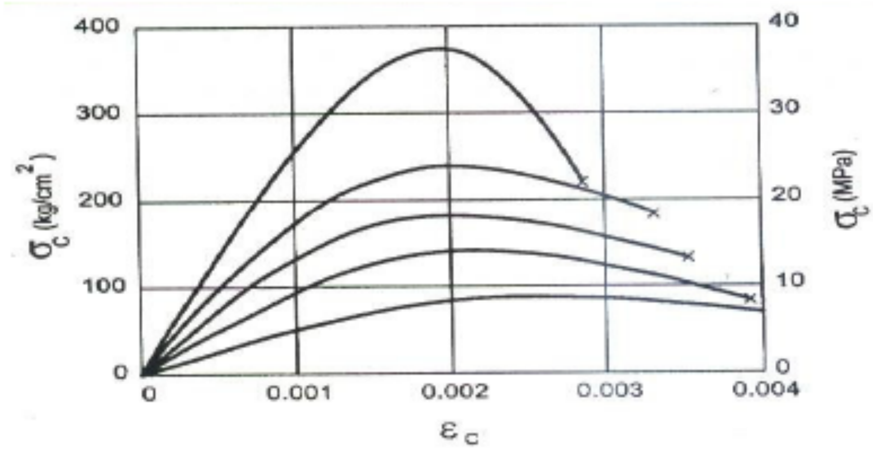

Figure 2.10. Concrete Stress-Deformation Curves Under Single Axis Pressure Effect

In Figure 2.10, stress deformation diagrams obtained for concretes with different strength under the effect of uniaxial pressure are shown. As can be seen, the o-£ curve of the concrete changes according to the type of concrete. As the concrete strength increases, the initial slope of the curves increases. Deformation values corresponding to compressive strengths for each concrete are similar to each other.

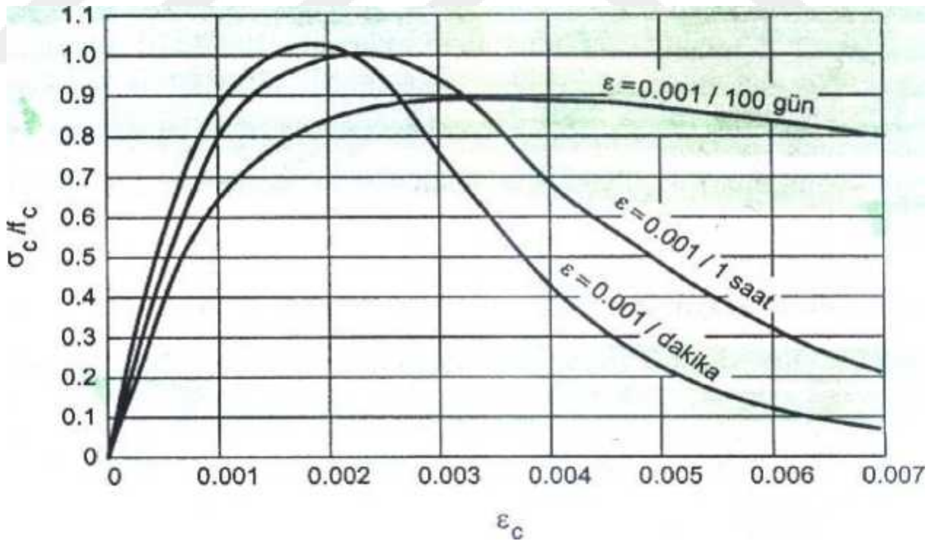

Figure 2.11. Effects of Loading Speed on the o-£ curve

Since concrete is a time-deforming material, the effect of loading speed on the stress deformation curve is great. As seen in Figure 2.11, as the loading speed decreases, the strength decreases, however, ductility increases.

One of the important factors affecting the stress-deformation relationship of concrete is the amount of winding. The stress-deformation effect of a concrete winded with stirrup or fret is quite different from that of non-wrapped concrete. Figure 2.12 shows the effect of the amount and forms of the winding on the stress-deformation curve (Ersoy and Özcebe, 2001).

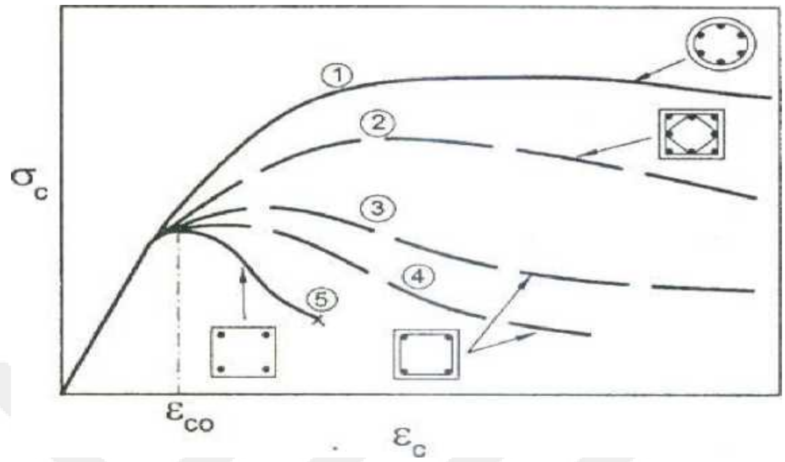

Figure 2.12. Winding Effect

In some cases, concrete is exposed to repeated stresses due to earthquake loads, wind loads and loads due to machine movements. Stress-deformation relations should be known in case of reloading and unloading of concrete under these forces. Many experiments and studies have been carried out on this subject and it has been shown how concrete behaves under the cyclic loads below.

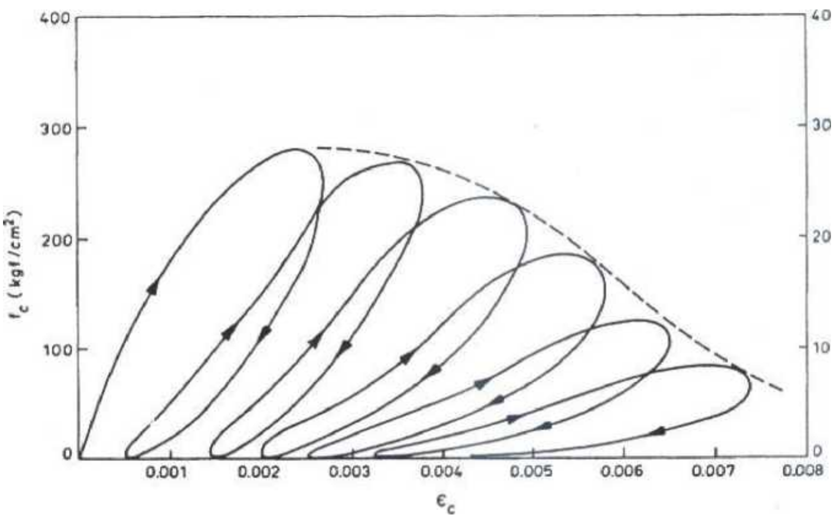

Figure 2.13. Stress-Deformation Curve of Concrete under Cyclic Loading

The test results show that the envelope curve of the curves found by repeating the load is the same as the uniaxially applied flat pressure loading curve. In Figure 2.13, it can be seen that as a result of the cyclic loading, the concrete softens and becomes more easily deformable. In addition, it is concluded that the slope of the stress-deformation curves, which are expressed as the stiffness of the concrete, decreases as a result of increasing the cyclic loading. Permanent deformations occur in concrete, which means that concrete does not exhibit elasticity.

2.4.3 Tensile Strength Of Concrete

Tensile strength of concrete is generally neglected in case of ultimate bearing capacity limit. However, in the case of workability limits, the tensile strength of concrete is used in calculations related to cracks. Tensile strength of concrete is very low compared to compressive strength. Tensile strength is approximately 10% of compressive strength. Tensile strength of concrete can be calculated as a result of experiments such as central tensile test, roller split test and beam bending test (Ersoy, Özcebe, 2001; Doğangün, 2007). The regulations are based on the tensile strength of concrete as a result of any of these experiments. For the tensile strength of concrete in TS-500, the value obtained from the axial tensile test is taken as basis and it is shown in Equation 1.

$$fctk = 0.35 \sqrt{fck} \quad \text{(MPa)} \tag{1}$$

2.4.4 Shear (Sliding) Strength Of Concrete

It is more difficult to determine the shear strength of concrete than to compressive and tensile strength since it is very difficult to obtain real shear breakage. Therefore, different values are given for the shear strength of concrete. Shear strength of concrete takes values ranging from 35% to 80% of compressive strength (1-3). Since the shear strength of concrete is higher than the tensile strength, breakage will occur with tensile breakage even in the case of simple shearing.

2.4.5 Elasticity Module Of Concrete

It is very difficult to determine the module of elasticity of concrete as concrete exhibits a non-linear elastic behavior. The elasticity module defined as the slope of the curve in the stress-deformation diagram will have different values for different stresses (Ersoy and Özcebe, 2001; Celep and Kumbasar, 2005). Three definitions have been made for the elasticity module of concrete. These are the initial module of elasticity, secant module and tangent module (Figure 2.14).

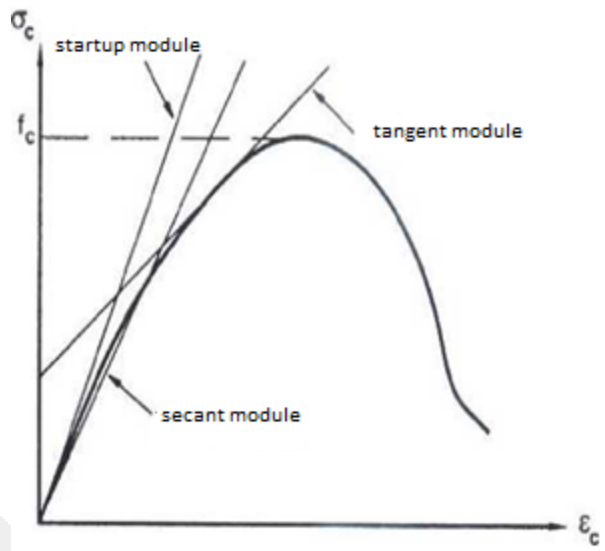

Figure 2.14. Elasticity Modules Of Concrete

Generally, when the module of elasticity is mentioned, the module of elasticity is sprung to mind under the sudden loading of 28 days of concrete. In TS-500, the elasticity module of daily concrete "j" for normal weight concrete is defined in Equation 2.

$$E_{cj} = 3250f + 14000 \text{ (MPa)} \quad (2)$$

2.4.6 Poisson Ratio Of Concrete, Shear Modulus And Heat Expansion Coefficient

In an element exposed to load effect in the longitudinal direction, the ratio of transverse deformation to longitudinal deformation is called the Poisson ratio (p) (1,3). In TS-500, this ratio is 0.2 for concrete.

The value of the shear module is accepted as in Equation 3 in 40% of the modulus of elasticity according to TS-500. Therefore, all the factors affecting the module of elasticity also affect the shear module.

$$G_q = 0.40E_q \quad (3)$$

The heat expansion coefficient of concrete varies depending on the cement dosage.

When the dosage increases, the expansion coefficient also increases. In TS-500, the heat expansion coefficient of concrete is accepted as at = 10^{-5} 1 / ^{o}C. Heat expansion coefficients of steel and concrete are very close to each other. For this reason, the two materials make similar deformations during temperature changes, so that concrete and steel work together in harmony without creating any negative situation.

CHAPTER 3

EXPERIMENTAL WORK

3.1 Scope Of Experimental Work

In the experiment, it was planned to produce a concrete with normal strength (without using chemical and mineral additives) consisting of cement, water and aggregate and to control and compare it with other mixtures. It is planned to compare silicate-based mineral additive silica smoke with fly ash in concrete instead of cement in terms of workability and strength properties. A total of 9 mixtures were made in this study. The amount and type of cement, aggregate and chemical additives in these mixtures were kept constant. Control a second mixture was made using 5.63 kg polycarboxylate based HP chemical additive at 1.25% instead of 45.6% water in the concrete; the third mixture, which is similar to the second mixture, was planned to change from only chemical additive polycarboxylate based HP to naphthalene based SP at the same rates. It is planned to use SF mineral additives in the fourth, fifth, sixth mixtures, 5%, 7.5% and 9% respectively in the second mixture. In the seventh, eighth and ninth mixtures, FA mineral admixture in the second mixture is intended to be used at the rates of 20%, 30% and 40% respectively. These mixtures between themselves concrete pressure resistances 1., 3., 7., 28., 56. and 90. they are scheduled to be compared in days.

3.2 Laboratory Devices Used In The Experiment

The study was carried out in laboratory environment and in this study (0.25 - 32) mm sieve analysis set, slump set, 100 dm capacity mixer concrete, 100 kg capacity weighing and 3 kg capacity precision weighing, (15 x 15) cm plastic cube sample containers and 200 tons loading capacity branded Test press were used.

3.3 Materials Used In Mixtures

3.3.1 Cement

In the study, CEM I 42.5 R class Portland Cement, which was produced in accordance with TS-EN 197-1 standards and brought directly from the factory to the concrete company, was used in silobas.

Some technical data for this Cement are given in Table 3.1.

Table 3.1. Chemical Properties Of Cement Used in Mixtures

Chemical	**Ratio %**	**Chemical**	**Ratio %**
MgO	1,01	Na_2O	0,32
K_2O	0,75	SO_3	2,72
Loss Of Glow	3,63	Cl	0,006
Unsolved Relic	0,18	C3S	70,07
C2S	0,14	C3A	7,32
C4AF	10,38		

Table 3.2. Physical Properties Of Cement Used in Mixtures

<table>
<tr><td rowspan="3">Strengths [N / mm2]</td><td>2</td><td>27,8</td><td colspan="2">Specific gravity</td><td>3,12</td></tr>
<tr><td>7</td><td>42,8</td><td colspan="2">Volume stability [mm]</td><td>0,5</td></tr>
<tr><td>28</td><td>49,9</td><td rowspan="2">Outlet Duration</td><td>Start [dk]</td><td>135</td></tr>
<tr><td rowspan="3">Point [%]</td><td>Specific Surface</td><td>3770</td><td>Last [dk]</td><td>235</td></tr>
<tr><td>0,090 mm sieve</td><td>0,4</td><td colspan="2"></td><td></td></tr>
<tr><td>0,032 mm sieve top</td><td>18,8</td><td colspan="2"></td><td></td></tr>
</table>

3.3.2 Aggregate And Crushing Stone Powder

Stone powder (0 - 3) mm and aggregates with grain diameter (4 - 16) mm and (11.2 - 22) mm were used for breaking from a quarry in accordance with TS706 EN 12620 standards.

Table 3.3. Some Characteristic Properties Of Materials Used in The Mixture

	0 - 3 mm stone	**4 - 16 mm aggregate**	**11,2 - 22 mm**
Water Intake %	2,6	0,47	0,28
Unit weight (ton/m^3)	1,67	1,54	1,52
Specific gravity	2,66	2,7	2,3
Finesse Module	2,09	5,35	6,45

Sieve analysis charts for these materials figure 3.1. has been given.

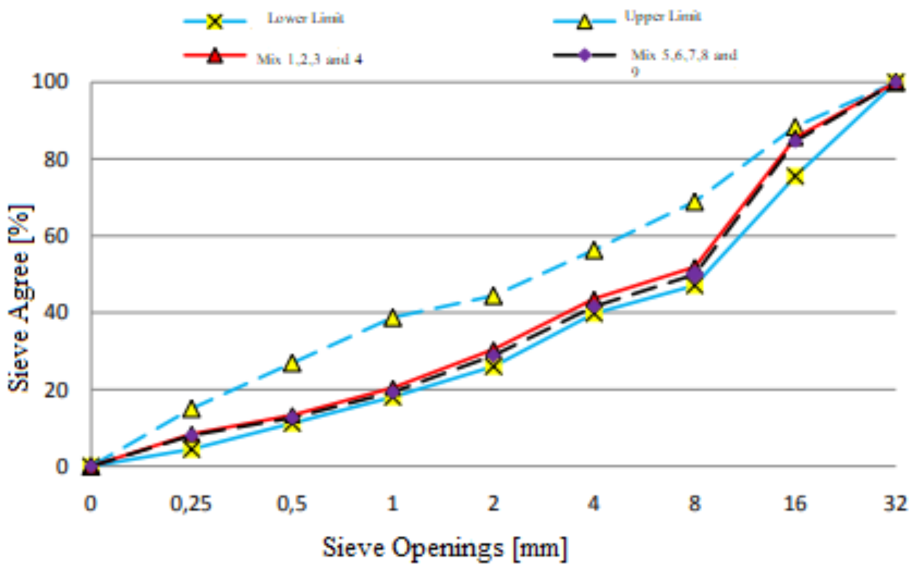

Figure 3.1. Aggregate Mixture Granulometry Curve

3.3.3 Chemical Additives

In the study, about 1.25% of cement content in naphthalene-based SP and polycarboxylate-based HP fluidizing mixture was used as chemical additives. It has been observed that when these additives are used over 1.5%, they cause socket delay in concrete.

Table 3.4. Some Characteristics Of Chemical Additives

Contribution	**Specific [g/cm^3]**	**Color**	**PH**	**% Water (Cl)**	**% Na_2O**
SP	1,05	Light Green	8 ± 2	< 0,1	< 1,5
HP	1,16	Coffee	7	< 0,1	< 1

3.3.4 Mineral Contributions

FA from thermal power plant and SF obtained from private company silicoferrochrome flue powder plants were used as mineral additives.

Table 3.5. Some Characteristics Of Mineral Additives

Mineral Admixture	**Specific Gravity [g/cm^3]**	**Specific Surface [cm^2/g]**	**Aggravation Loss**	**% Puzzolanik Aktivite**	45 µm electe remaining %
FA	1,99	3324	1,00	70,66	21,9
SF	2,5	144000	1,84	85	7

3.4 Preparation Of Mixtures

In the study, the mixtures produced routinely in accordance with TS-EN 206 - 1 standards in a concrete company were carried out in a laboratory environment. The aim of this study was to investigate the workability and pressure strengths of concrete by using SP and HP, which are composed of chemical additives, FA and SF, which are composed of mineral additives. The maximum grain diameter in these mixtures is 22 mm. In the Study Laboratory mixer was used for the mixture the concretes produced by determining the mixture time according to Ts were taken to wheelbarrow first by measuring the temperature and then by measuring the concrete slump quantities, air determination was made by air meter and the concrete was placed in standard cube sample containers of 15 x 15, and kept in a laboratory environment at 20 ± 2 After the samples were removed from the mold, they were placed in the curing pool at a temperature of 20 ± 2 oC.

Figure 3.2. Preparation Of The Intended Subject

Figure 3.3. Preparation Of The Intended Subject

Figure 3.4. Preparation Of The Intended Subject

Figure 3.5. Preparation Of The Intended Subject

Figure 3.6. Preparation Of The Intended Subject

Figure 3.7. Preparation Of The Intended Subject

Figure 3.8. Preparation Of The Intended Subject

Figure 3.9. Preparation Of The Intended Subject

Figure 3.10. Preparation Of The Intended Subject

Figure 3.11. Preparation Of The Intended Subject

Stages Of Preparation Of Mixture

1. measure temperatures with cement, water, aggregate, SF, FA, HP and SP weigh
2. add and mix dry ingredients into the mixer
3. add water to achieve homogeneous paste and consistency, then compare hp with water
4. when the mixture is ready, the temperature of the fresh concrete is measured and taken into the wheelbarrow
5. Air determination is done with Slump experiment and unit weight is measured
6. 15x15 standard cube sample containers are placed in laboratory environment for 24 hours
7. At the end of 24 hours, the first day a press resistance test is performed and other samples are taken to the curing pool at room temperature.
8. pressure testing of samples is done with press test machine on the first, third, seventh, twenty-eighth, fifty-sixth and ninetieth days.

Figure 3.12 Getting The Mix In The Wheelbarrow

Figure 3.13. Mixing And Temperature Measurement

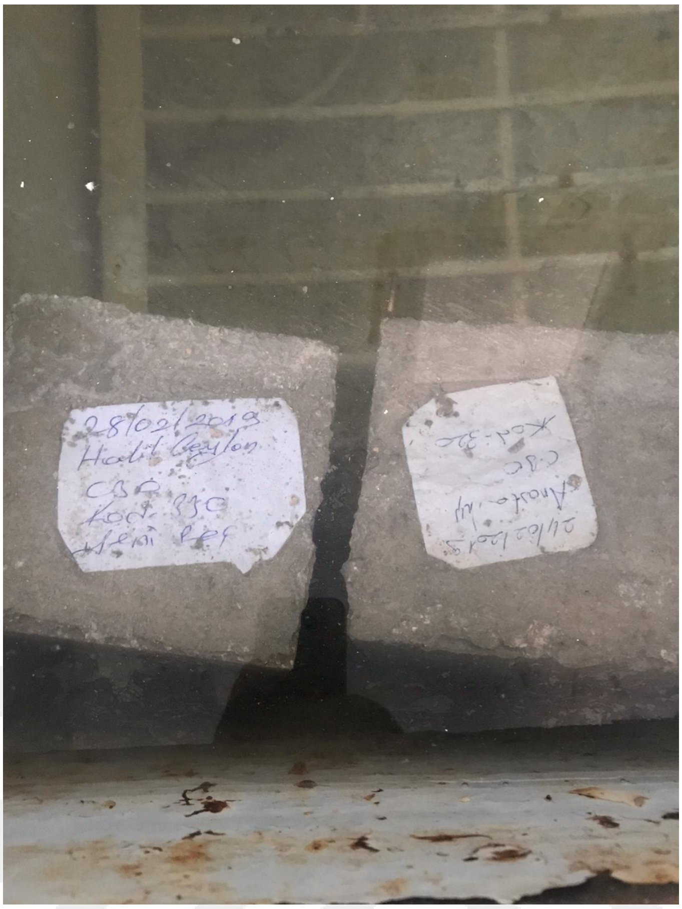

Figure 3.14. View Of Samples

9 different mixtures were produced in the study. First of the mixtures, a concrete with normal strength (without chemical and mineral additives) consisting of cement, water and aggregate was produced to control and compare to the other 8 mixtures. The amount and type of cement, aggregate and chemical additives in these mixtures were kept constant. A second mixture with a slump consistency of 16 cm was produced using 5.63 kg of chemical additives in 1.25% instead of 46.3% water (132 lt water was removed) in the control concrete, while a slump of 15 cm was observed in the control sample.

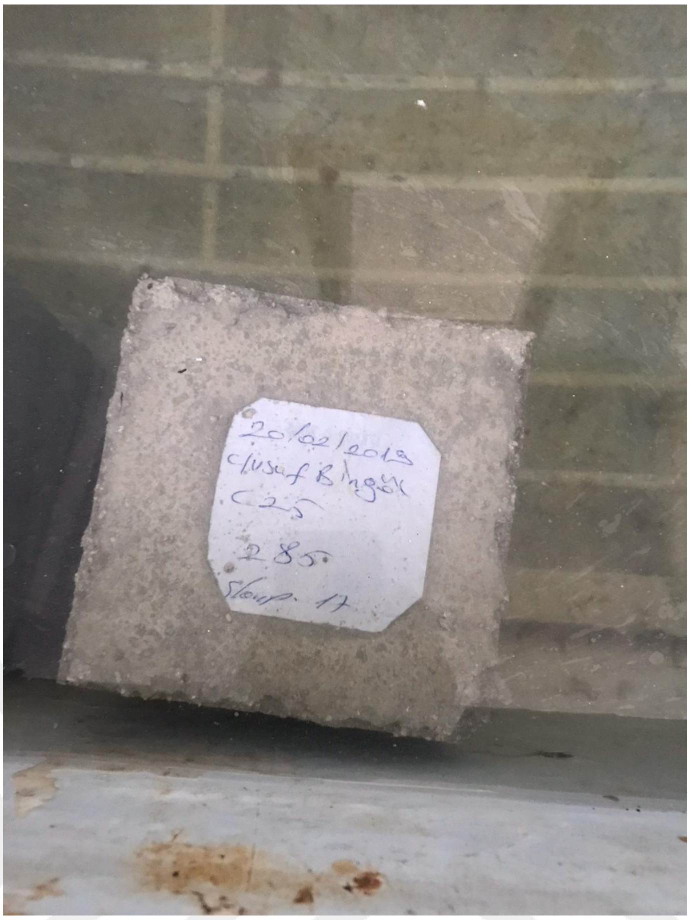

Figure 3.15. Appearance Of Broken Sample

The third mixture, which is similar to the second mixture, was replaced with 45.6% water (130 lt water was removed), the same proportion was changed from only chemical additive HP to SP, and concrete with 15 cm slump consistency was produced . In the fourth mixture, 17 cm slump consistency of concrete is produced by reducing 121 lt water and adding 5% silica fume mineral additives. In the fifth mixture, concrete with slump consistency of 16 cm has been produced by reducing 119 lt water and adding 7.5% silica fume mineral additives . In the sixth mixture, 15 cm slump consistency of concrete is produced by reducing 116 lt water and adding 10% silica fume mineral additives.

In the seventh mixture, 16 cm slump consistency of concrete is produced by reducing 141 lt water and adding 20% fly ash mineral additives . In the eighth mixture, 17 cm slump consistency of concrete is produced by reducing 128 lt water and adding 30% fly ash mineral additives. In the ninth mixture, 18 cm slump consistency of concrete is produced by reducing 128 lt water and adding 40% fly ash mineral additives. Prepared mixture ratios Table 3.6 'is also given.

Table 3.6. Mix Designs

Mix 1 control sample		
Material Type	**1 m³ for concrete [Kg]**	**33 dm³ for concrete [Kg]**
Cement	450	14,85
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	285	9,40

Mix 2 control sample %1,25 HP		
Material Type	**1 m³ for concrete [Kg]**	**33 dm³ for concrete [Kg]**
Cement	450	14,85
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	153	5,04
HP	5,63	0.185

Mix 3 control %1,25 SP		
Material Type	**1 m³ for concrete [Kg]**	**33 dm³ for concrete [Kg]**
Cement	450	14,85
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	155	5,11
SP	5,63	0.185

Mix 4 control %5 SF		
Material Type	**1 m³ for concrete [Kg]**	**33 dm³ for concrete [Kg]**
Cement	427,5	14,10
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	164	5,41
HP	5,63	0.185
SF	22,5	0,74

Mix 7,5 control %5 SF		
Material Type	**1 m³ for concrete [Kg]**	**33 dm³ for concrete [Kg]**
Cement	416,25	13,73
(0-3) aggregate	667	22,01

(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	166	5,47
HP	5,63	0.185
SF	33,7	1,11

Mix 6 control %10 SF		
Material Type	**1 m^3 for concrete [Kg]**	**33 dm^3 for concrete [Kg]**
Cement	405	13,36
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	169	5,57
HP	5,63	0.185
SF	45	1,48

Mix 7 control %20 FA		
Material Type	**1 m^3 for concrete [Kg]**	**33 dm^3 for concrete [Kg]**
Cement	360	11,88
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	144	4,75
HP	5,63	0.185
FA	90	2,97

Mix 8 control %30 FA		
Material Type	**1 m^3 for concrete [Kg]**	**33 dm^3 for concrete [Kg]**
Cement	315	10,39
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	157	5,18
HP	5,63	0.185
FA	135	4,45

Mix 9 control %40 FA		
Material Type	**1 m^3 for concrete [Kg]**	**33 dm^3 for concrete [Kg]**
Cement	270	8,91
(0-3) aggregate	667	22,01
(4-16) aggregate	574	18,94
(11,2-22) aggregate	652	21,51
Water	157	5,18
HP	5,63	0.185
FA	180	5,94

For these mixtures, material, ambient and concrete temperatures were measured and their effects on fresh concrete were investigated.

Table 3.7. Materials, Media And Concrete Temperatures

Concrete Type	**Cement Temperature [°C]**	**water temperature [°C]**	**concrete temperature [°C]**	**ambient temperature [°C]**
B1- Control	50	21.2	26.5	27.8
B2-HP	45	29	33.8	37
B3-SP	50	29.2	33.3	36
B4-%5 SF	50	29	37	38
B5-%7.5 SF	50	29	37.7	39
B6-%10 SF	50	29	38.1	37
B7-%20 FA	50	29	37	37
B8-%30 FA	50	29	31.2	27
B9-%40 FA	50	29	32.6	32

By adding SP and HP as chemical additives and SF and FA as mineral additives in different proportions to the control sample, the following conclusions were drawn at the initial stage.

- Excessive temperature of cement affects the concrete temperature and indirectly speeds up the outlet.
- All FA substituted concrete, although we reduce the most water and no water without cutting the most slump observed in these mixtures are the mixtures that cause the most receptacle displacement.
- Generally all SF substituted concrete, and especially in the sixth mixture (10% SF), has been observed to shorten the setting time despite 41.4% of our water reduction and the mixture that cuts the most water.
- HP substituted concrete (second mixture), which needs less water, has shown more slumps than SP substituted concrete (third mixture). This shows that the HP contribution has more impact on fresh concrete..

3.5 Fresh Concrete Test Results

In fresh concrete experiments, the concrete subsidence value (slump) decreased as the SF substitution rate increased. This is because very fine grains of silica smoke enter between the larger cement grains, pushing the water trapped here out and become effective on the consistency of the fresh dough. Despite this positive effect, the large surface area formed by silica fume grains will increase the water requirement and negatively affect the consistency. Therefore, it can be explained by the increasing need for concrete water. In reverse case FA substituted concretes, the subsidence value increased as the ratio increased. This is because the FA particles are small and round, which increases the cohesion and workability of the concrete at a certain subsidence value. The amount of mixed water required to achieve the target subsidence is usually reduced by the use of FA and increased by the use of SF.

Determination of the amount of air in fresh concrete was made by pressure method. The mixture of fresh concrete was filled with 3 layers 25 times by skewering into the measuring cup. After the skewering of each layer, the air bubbles remaining in the concrete were removed by hitting the sides of the container 10 to 15 times. The excess on the container was stripped away. Cover the seat is cleaned thoroughly and the cover is placed in place and locked. The main air tap between the air cell and the measuring cup was closed and the drain tap in the lid was opened and water was added to the device. The air discharge tap was turned off and the air was pumped until it reached the pressure line with the manometer gauge. After 3 to 5 seconds, the air was pumped again to stabilize the indicator and sometimes emptied. Then the drain taps in the lid were turned off and the main air tap between the cell and the container was opened. After the indicator is fixed, the amount of air shown by the needle is read and recorded as%.

Fresh unit weight experiment. Before starting the experiment, the empty weight of the measuring cup suitable for aggregate grain size was weighed and recorded. Fresh concrete mixture is filled into the container in three layers 25 times by skewering. The sides of the container 10 to 15 times by hitting the space and air if there is removed. The surface of the concrete is cleaned by stripping with a stripping Rod. The cap is stripped and fresh concrete is weighed. The net weight of the concrete is calculated by deducting the weight of the container.

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Fresh unit weight experiment. Before starting the experiment, the empty weight of the measuring cup suitable for aggregate grain size was weighed and recorded. Fresh concrete mixture is filled into the container in three layers 25 times by skewering. The sides of the container 10 to 15 times by hitting the space and air if there is removed. The surface of the concrete is cleaned by stripping with a stripping Rod. The cap is stripped and fresh concrete is weighed. The net weight of the concrete is calculated by deducting the weight of the container. Table 3.8 as a result of the experiment.'is also given.

Table 3.8. Fresh Concrete Test Results

Concrete Type	**Crash [cm]**	**unit weight [kg/m3]**	**Air quantity [%]**
B1-Control	15	2373	1,3
B2-HP	16	2459	0,9
B3-SP	15	2489	1,3
B4-%5 SF	17	2475	1,0
B5-%7.5 SF	16	2463	0,9
B6-%10 SF	15	2454	0,8
B7-%20 FA	16	2475	1,2
B8-%30 FA	17	2438	0,8
B9-%40 FA	18	2421	1,0

The air quantity values of all fresh concrete are between 0.8% and 1.3% and there is no significant change with the substitution of SP, HP, SF and FA can be seen in Table 16 Similarly, unit weight in fresh concrete has been reduced slightly by increasing SF and FA ratio.

3.6 Concrete Pressure Test Results

1., 3., 7., 28., 56. ve 90. day pressure strengths of the concrete samples produced are as given in Table 3.9.

Table 3.9. Strength / Age

Day **Sampling**	**1**	**3**	**7**	**28**	**56**	**90**
Pressure Resistances [MPa]						
B1-Control % 0 SP, HP % 0 SF % 0 FA	20,2	30	31,7	37,3	41,4	42,8
B2 % 1.25 HP % 0 SF % 0 FA	42	53,9	49,9	53	56,7	58,3
B3 % 1.25 SP % 0 SF % 0 FA	45,9	48,7	43,4	50,1	55,3	57,6
B4 % 1.25 HP % 5 SF % 0 FA	36,4	44,1	50,8	57,8	63,4	61,7
B5 % 1.25 HP % 7.5 SF % 0 FA	37,8	45,5	50,5	57	64	60,6
B6 % 1.25 HP % 10 SF % 0 FA	38	47,4	55,8	60,6	66,3	61,6
B7 % 1.25 HP % 0 SF % 20 FA	40,2	47,4	53,8	62,5	71,3	67,5
B8 % 1.25 HP % 0 SF % 30 FA	38,9	45,8	47,5	59,2	72,4	69,6
B9 % 1.25 HP % 0 SF % 40 FA	33,4	42	45,8	60,1	73,7	71,8

The single axis pressure test performed on control, SP and HP reinforced concrete produced in the scope of the study in 1, 3, 7, 28, 56 and 90 days is given in Table 3.9.

When the results presented in the table were examined, the compressive strength values in SP and HP doped concrete (as shown in figure 3.16) were higher than in control concrete and HP doped concrete showed better results than SP doped concrete. This is because the fluidizing agent is deposited on the surface of the grain as a result of being adsorbed by cement grains. The film formed by these substances deposited on the surface of the grain is negatively charged with electricity. In this way, negative electric charged grains repel each other and the dispersive effect of these substances occurs. These substances prevent clumping and at the same time when they make it easier for the grains to slip on each other, reducing the internal friction of the concrete, which leads to increased workability of the concrete and decreases the required mixture water in the same consistency, so since the strength is the function of the water/cement ratio, higher, early and final strength will be obtained,

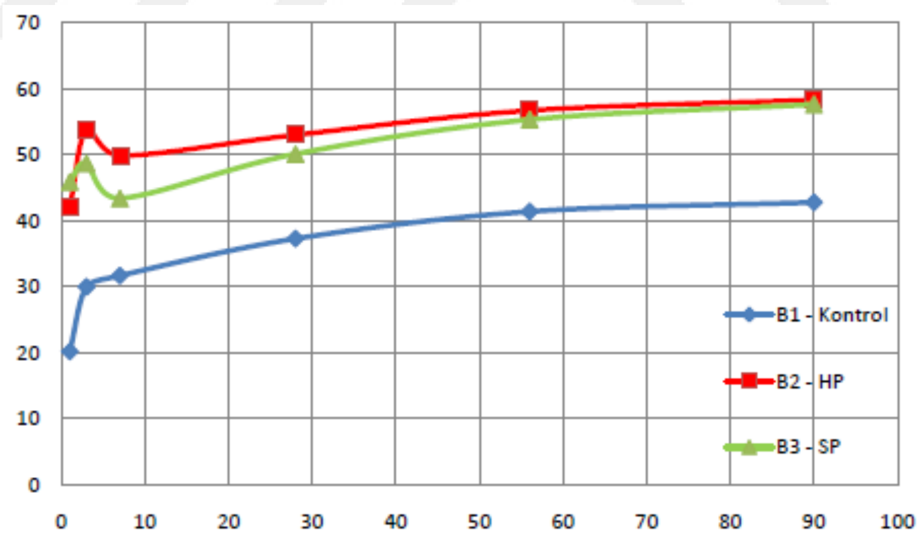

Figure 3.16. Time Relation With B1-Control, B2-HP and B3-SP Pressure Strengths.

1, as seen in Table 3.9 and figure 3.16. - day compressive strength examined; the concrete is expected to show higher strength than the concrete ikamel SF FA SF SiO2 ikamel cooling from high starting at a very early age because the reactions contain the new C–S–H gels and is expected to provide for the formation of very fine-grained to be aggregate-concrete strength increases the surface area of the dough by strengthening toning Dec. But in this group, the results of SF and FA substituted concretes are almost identical, which means that the Puzolanic reactions of SF substituted concretes begin 1 day after the start of hydration of cement, 3. that it became apparent after day 28. research has also shown that it is largely completed per day.

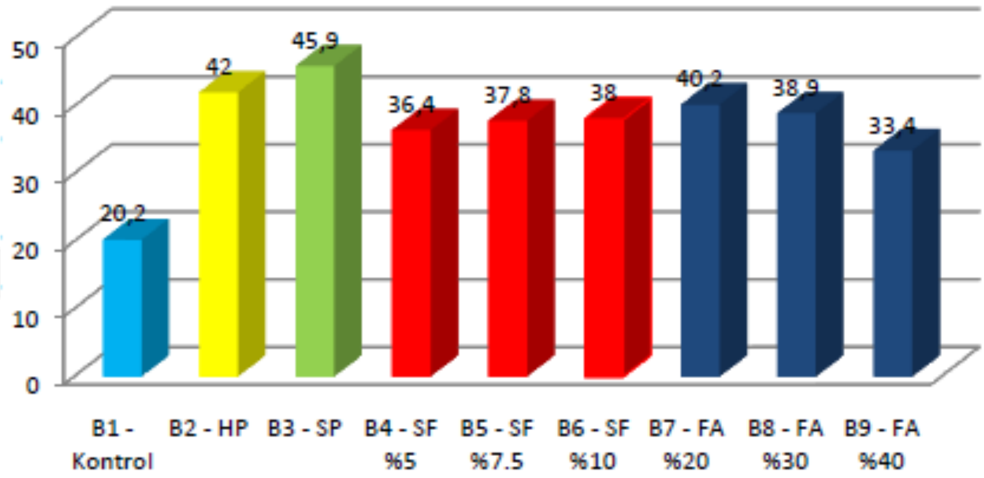

Figure 3.17. Relationship Between Pressure Resistance And Mixtures For The 1. Day

The highest compressive strength B3-SP concrete sample yielded 45.9 MPa. The best explanation for this situation is that strength is the function of the water/cement ratio, so higher, early and final strengths have been obtained because the reduction of the mixture water will decrease the water/cement ratio, and it can be explained that SF and FA"Li substituted concretes do not become more pronounced at the first age. At the same time, as the SF ratio increases, pressure resistance increases. However, on the contrary, it is observed that the pressure resistance decreases as the FA ratio increases in FA reinforced concrete. The lowest pressure resistances yielded a value of 33.4 MPa of B9 (40% FA substituted concrete). This can be explained by the small, full and spherical structure of the FA grain because it distorts the socket by adsorbing less water.

As seen in Table 3.9 and figure 3.17, 3-day pressure resistances were examined; the highest pressure resistances were shown as 53.9 MPa in B2-HP concrete. The lowest pressure resistances yielded a 42 Mpa value of B9 (40% FA substituted concrete), which is due to the increase in the FA ratio in the concrete and the spread of strength over time. The same situation is observed here, and the same reasons for the first day can be explained. As the SF ratio increases, the strength increases, and as the FA ratio increases, the strength decreases.

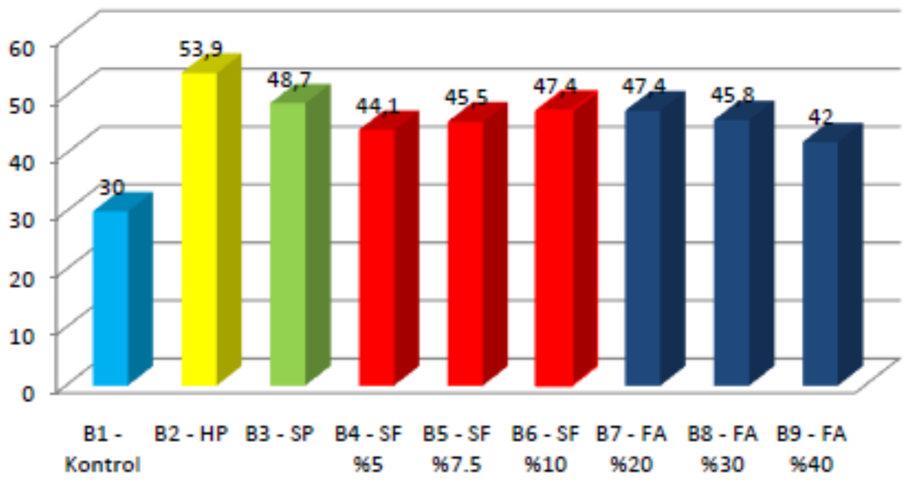

Figure 3.18. Relationship Between Pressure Resistance And Mixtures For The 3. Day

As can be seen in Table 3.9 and figure 3.18, when the 7-day pressure resistances are examined, the compressive strength increases as the SF ratio increases. When the FA increases, the strength decreases. In this group, the highest compressive strength B6 (10% SF substituted concrete) yielded 55.8 MPa concrete samples, which proves that Puzolanic reactions of SF substituted concrete became evident after the third day of hydration of cement. The lowest compressive strength yielded a concrete sample of B-SP 43.4 MPa, which showed that SF and FA doped concretes became apparent as time progressed.

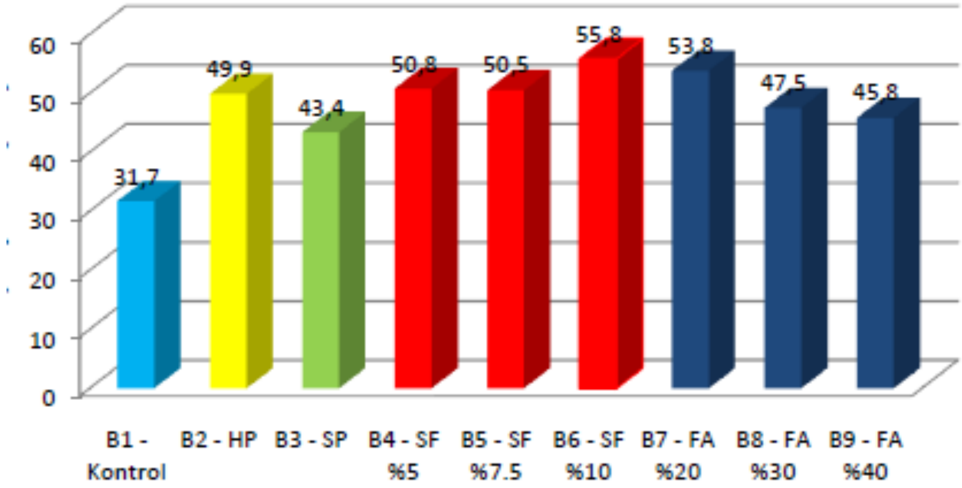

Figure 3.19. Relationship Between Pressure Resistance And Mixtures For The 7. Day

As shown in table 3.9 and figure 3.19, 28-day pressure resistances are examined; FA reinforced concrete is more resistant than SF"Li concrete.

The highest pressure resistance value of B7 (%20 FA substituted concrete) was 62.5 MPa, the pressure resistance of FA substituted concrete is low at early age and high at advanced age is similar to the literature, 7. 28 compared to the difference between 20% and 40% FA substituted concrete on the day. it has been observed that this difference decreases per day. The reason for this can also be explained as the proportion of FA contribution has more impact because it is more. The lowest compressive strength yielded a concrete sample of B3-SP 50.1 MPa.

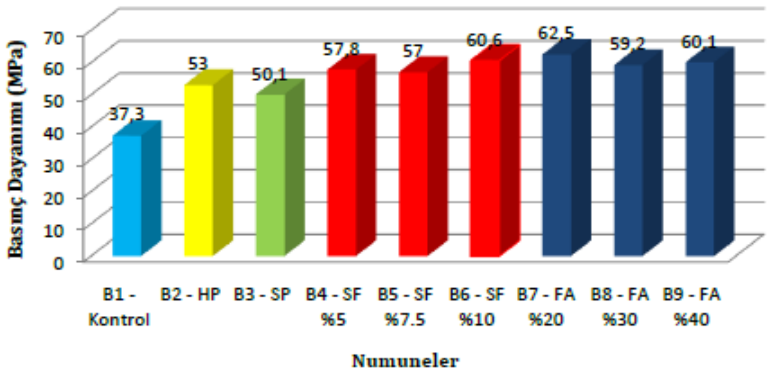

Figure 3.20. Relationship Between Pressure Resistance And Mixtures For The 28. Day

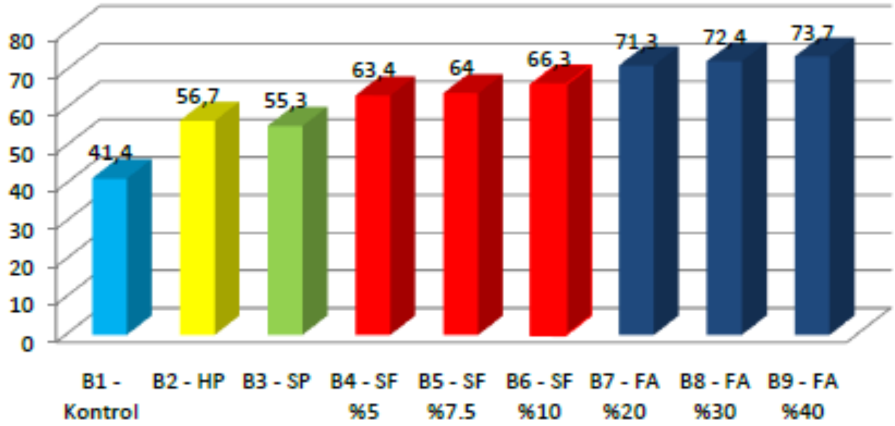

Figure 3.21. Relationship Between Pressure Resistance And Mixtures For The 56. Day

As can be seen in tablo 3.9 and figure 3.21, 56-day pressure resistances are examined; FA"Li concrete is higher than SF"Li concrete, this is because of the increase in age of the concrete with FA puzolanic activity increases. The highest compressive strength value was B9 (40% FA substituted concrete) with 73.7 MPa concrete samples, where, as described above, strength increased as the FA additive ratio increased. At the same time, SF rates increase more resistance shows. The lowest compressive strength yielded a concrete sample of B3-SP 55.3 MPa.

As shown in tablo 3.9 and figure 3.22, 90-day pressure resistance is examined; FA"Li concrete is higher than SF"Li concrete, but 56 days lower than the strength, which can be explained because they are samples. 90 days of FA and SF"Li substituted concretes were not considered appropriate to be evaluated as the results were questionable. The lowest compressive strength yielded a concrete sample of B3-SP 57.6 MPa.

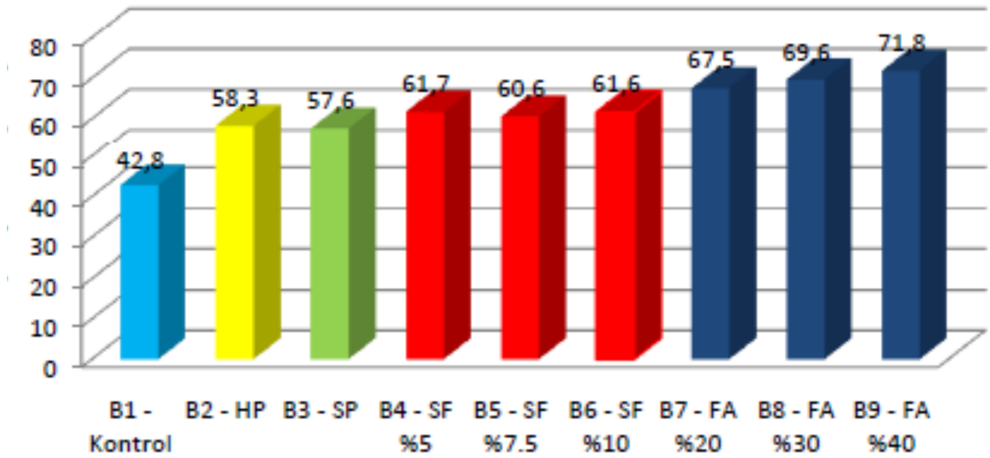

Figure 3.22. Relationship Between Pressure Resistance And Mixtures For The 90. Day

As shown in tablo 3.9 and Figure 3.22, 56 days of reference concrete was taken and SP, HP, SF and FA substituted concrete increase was examined; 5%, 7.5% and 10% SF substituted concrete showed 57.4%, 59.1% and 57.3% strength increase for the first day, respectively. 20%, 30% and 40% FA substituted concrete showed 55.3%, 53.7% and 45.3% strength increase, respectively, this increase decreases as FA ratio increases and 40% FA substituted concrete showed the lowest strength increase. HP reinforced concrete with 74.1% increased strength showed slower strength growth than SP reinforced concrete with the highest 83% increased strength. Control concrete gave a 48.7% increase in strength.

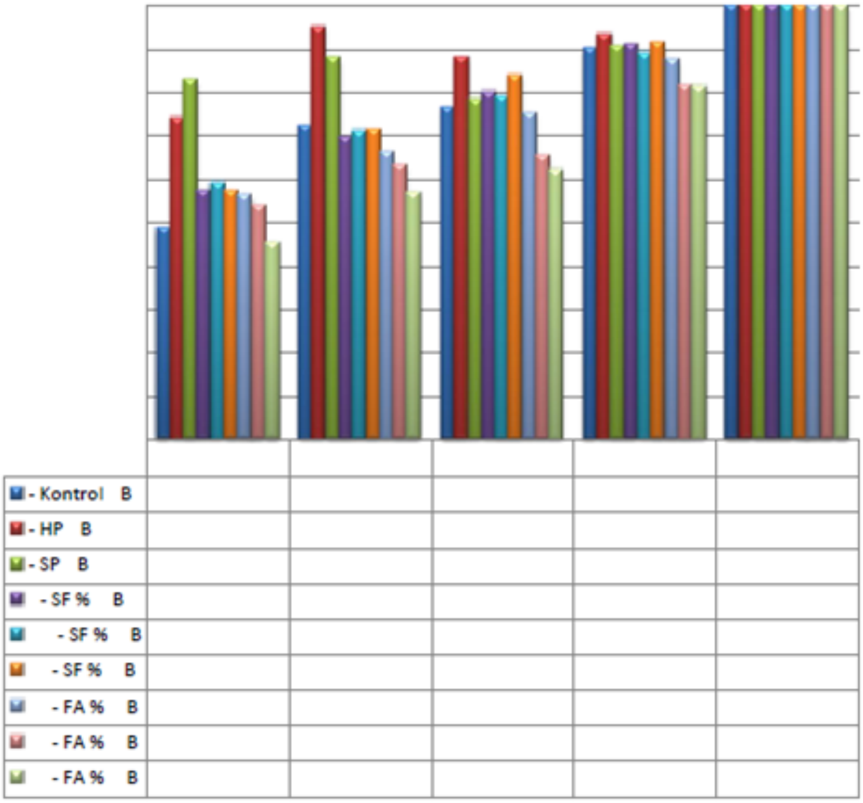

Figure 3.23. İncrease İn Concrete Strength Depending On Concrete Code And Age

When we examine the third day, 5%, 7.5% and 10% SF substituted concrete showed an increase in strength of 69.5%, 71.1% and 71.4% respectively, and as the SF ratio increases, it can be seen that the increase in strength increases. 20%, 30% and 40% FA substituted concrete showed the lowest strength increases of 66.4%, 63.3% and 56.9% respectively, this increase decreases as FA ratio increases and 40% FA substituted concrete showed the lowest strength increases. HP reinforced concrete with the highest 95.1% increase strength showed faster strength increase than SP reinforced concrete with 88.1% increase strength. Control concrete gave a 72.4% increase in strength. Here we can see how the FA contribution inversely affects the increase in concrete strength.

On the seventh day, 5%, 7.5% and 10% SF substituted concretes showed an increase in strength of 80.1%, 78.9% and 84.1% respectively, where SF substituted concretes clearly show how rapidly they became apparent at the first age. 20%, 30% and 40% FA substituted concretes showed the lowest strength increases, 75.4%, 65.6% and 62.1% respectively, this increase decreases as the FA ratio increases, and 40% FA substituted concrete showed the lowest strength increases. HP reinforced concrete with the highest 88% increase strength showed a faster increase in strength than SP reinforced concrete with 78.4% increase strength. Control concrete gave a 76.5% increase in strength.

When we examined the twenty-eighth day, 5%, 7.5% and 10% SF substituted concrete showed an increase in strength of 91.1%, 89.1% and 91.4% respectively, where SF substituted concrete showed how the puzolanic reactions of cement hydration were largely completed at this age. 20%, 30% and 40% FA substituted concretes showed the lowest strength increases, 87.6%, 81.7% and 81.4% respectively, this increase decreases as the FA ratio increases, and 40% FA substituted concrete showed the lowest strength increases, which makes the FA substituted concretes try to become prominent after the seventh day. This increase falls as the FA rate increases. HP reinforced concrete with the highest 93.4% increase strength showed faster strength increase than SP reinforced concrete with 90.5% increase strength. Control concrete gave a 90.1% increase in strength.

Figure 3.24 as seen when FA substituted concrete is examined; 40% FA substituted concrete shows the highest resistance on fifty-sixth day despite showing the least resistance at the first age and increasing the pressure resistance with the increase of FA ratio is observed.

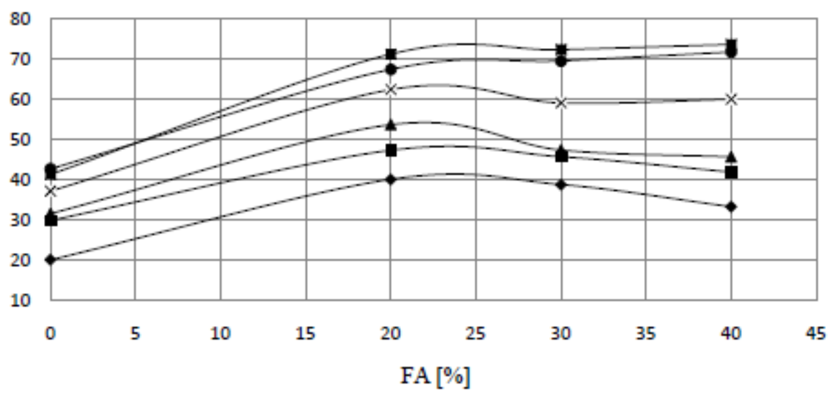

Figure 3.24. Relationship Of FA Substituted Concrete With Compressive Strength

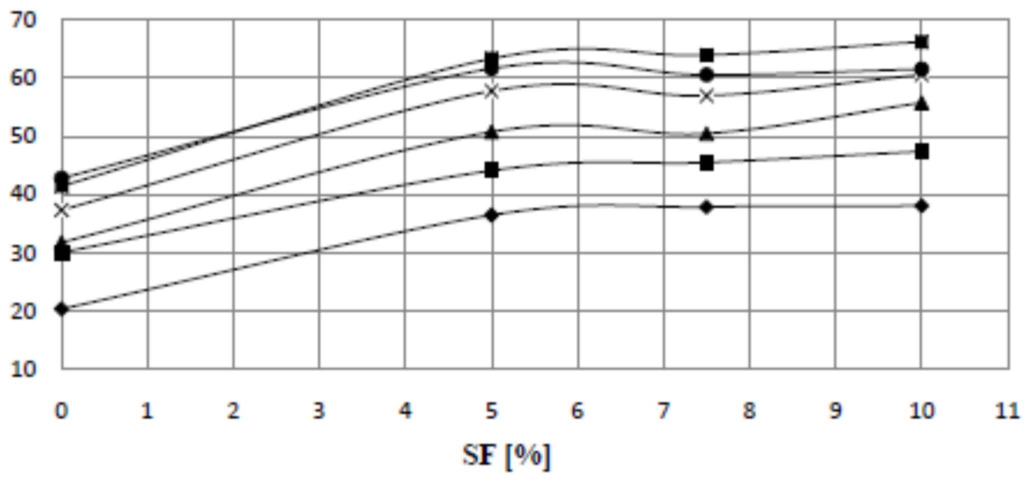

Figure 3.25. Relation of SF Substituted Concrete With Compressive Strength

As shown in tablo 3.9 and Figure 3.25 when the SF substituted concrete is examined, it is seen that the SF ratio increases and the pressure strength increases and the 10% SF substituted concrete has the highest strength.

When the pressure strength of SF and FA substituted concretes (as shown in Figure 3.26) is compared, all FA substituted concretes show higher strength than SF substituted concretes according to the results obtained from these ratios.

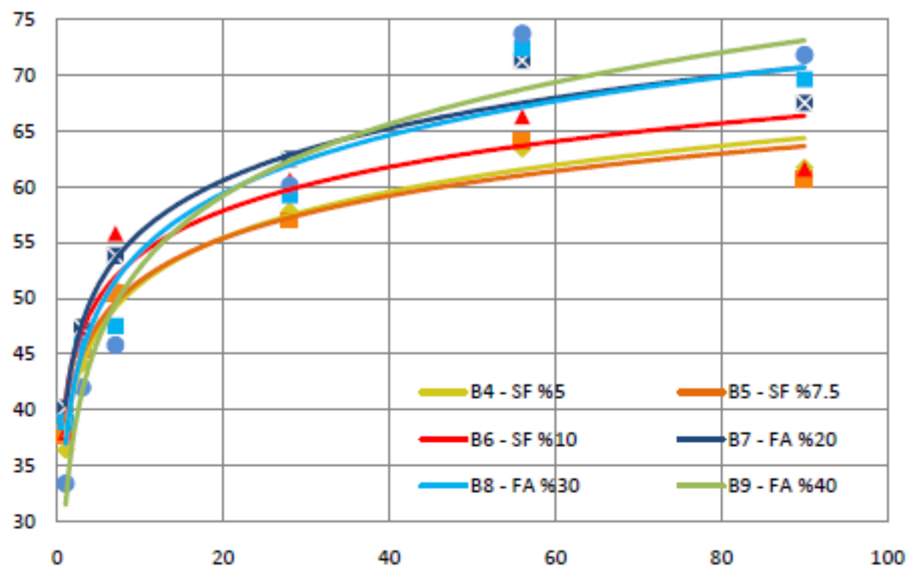

Figure 3.26. Comparison Of Pressure Strengths Of SF and FA Substituted Concretes

CHAPTER 4

RESULTS AND RECOMMENDATIONS

As a result of the studies and experiments, it was observed that the workability of concrete produced by the use of chemical additives increased, the water/cement ratio decreased, and the pumpability increased. It can be said that the preferred additive is primarily based on strength and changes according to the rate of cleanness of the aggregate to be used.

If we make a generalization for the use of chemical additives in Mardin region, it can be said that the most preferred additive is superfluidizers. As a result of the research, it shows that the additives with the same function are used in general according to the type of properties desired to be imparted to the concrete.

In some different concrete plants, the pressure resistance of the concrete produced using chemical additives has resulted in close ratios. The preferred admixture for the C25 concrete class used in general has been shown to be the preference for superfluidizers.

Due to the weather changes due to the season, the installation of concrete makes the use of chemical additives inevitable due to the problems experienced in terms of its strength, workability and durability. As weather conditions change during the year, the preferred chemical additive variety increases. Knowledge, experience, supervision and experiments are required since the chemical contribution used is different. As a result of the unconscious use of chemical additives negatively affects the properties of concrete.

There is no theoretical difference between Ready Mixed Concrete produced in developed countries and ready mixed concrete produced in our country. However, the lack of awareness, knowledge and training of pump operators and personnel such as transmixer drivers adversely affect the quality of concrete, although they increase the interest and supervision of responsible persons compared to previous periods.

It is inevitable that the stream bed sand used by ready-mixed concrete producers in Mardin region will be salty and cause permanent damage to the structure in later times as it is not properly washed and sieved. Although it is known that controls are increasing compared to the past, it is understood that they are not at the desired rate or are ignored unconsciously. There are not enough fresh water deposits in each region, and therefore, it is obligatory that stream bed sand from saltwater deposits will be available only after the necessary procedures have been done.

In order to improve the quality of concrete, it is important for manufacturers to use the aggregate as clean and washed, to use the cement at the desired dosage and to make the necessary analyses and most importantly to make the mixture with the aggregate in the appropriate granulometry by making sieve analysis.

In terms of technical information, ready-mixed concrete producers must benefit from engineers. At the same time, ready-mixed concrete producers, if they cooperate with the necessary places to do some checks that they can not do will be useful.

The most important issue for ready-mixed concrete producers is the potential for unskilled workers to be converted into qualified labor force through some training courses. Operators such as pumps, mixers and plent should be required to obtain certificates and, where necessary, courses should be organised.

The aim of higher quality and controlled ready mixed concrete production in our country is to increase the production of quality concrete with the performance level that will provide the conformity condition of the product, to expand the application area, to expand the level of industrialization and contribute to the social benefit.

4.1 Results

- SF and FA are mineral additives that give positive results in obtaining high performance concrete and mortar.

- Since the large SF-specific surface will increase the water requirement, it will be appropriate to use with HP or SP.

- SF used in the first few days of compressive strength gain speed is fast, but this speed decreases in later ages. While the rate of gaining pressure resistance in the first days of FA substituted concrete is slow, this speed is accelerated in the later ages.

- The rate of gaining strength is inversely proportional to the FA ratio, i.e. the rate of gaining strength decreases as the FA ratio increases. On the contrary, as the SF rate increases, the rate of gaining strength increases.

- HP substituted concrete has shown a faster increase in strength than SP substituted concrete.

- The use of silica fume SF in concretes with equal workability should be expected to provide a significant increase in pressure resistances. 56. 5% SF substituted concrete, 53.1% compared to control concrete, 11.8% compared to HP substituted concrete, 7.5% SF substituted concrete, 54.6% compared to control concrete, 12.8% compared to HP substituted concrete, 10% SF substituted concrete, 60.1% compared to control concrete, 16.9% compared to HP substituted concrete showed increased strength.

- The use of fly ash FA in concretes with equal workability should be expected to provide a significant increase in pressure resistances. 56. 20% FA substituted concrete, 72.2% according to control concrete, 25.7% according to HP substituted concrete, 30% FA substituted concrete, 74.8% according to control concrete 27.7% according to HP substituted concrete, 40% FA substituted concrete, 78% according to control concrete, 30% according to HP substituted concrete showed increased strength.

    - In all FA substituted concretes, slump has been observed to increase as the FA ratio increases, even though we reduce the water the most and without cutting any water, otherwise slump has been observed to decrease as the SF ratio increases, even though we reduce the water the least for SF substituted concretes and the mixtures that cut the most water.

4.2 Recommendations

- According to the results obtained in the experiments, this section will shed light on future studies and suggestions about the use of the material in the market.
- It is recommended to produce 35% to 50% FA and 15% to 20% SF substitutional mixtures in order to obtain the highest strength and to find the FA and SF ratio that best suits it. Once these conclusions are reached, the optimal FA and SF ratio can be found.
- It is recommended to use a minimum of three samples in concrete strength tests in order to avoid any doubt conclusions.
- Experiments showed that using high temperature cement affects the workability of fresh concrete in the opposite direction.

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