Faculty of Science and Engineering

Department of Civil Engineering

Residual mechanical properties of steel fibre reinforced geopolymer concrete (SFRGC) after exposure to elevated temperatures

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

Date: 20/04/2016

ABSTRACT

The utilization of fly ash geopolymer as a binder gained its popularity in recent years due to its environmental friendliness and excellent mechanical and durability properties in severe environment. Excellent fire resistance is its most significant advantage over cement based binder due to its ceramic like property.

The main aim of this study is to evaluate the residual mechanical properties of steel fibre reinforced geopolymer concrete and compare the results with the residual mechanical properties of steel fibre reinforced concrete after exposure to elevated temperatures. This study is divided into two parts. First part presents the effects of sodium and potassium based activators on compressive strengths and physical changes of class F fly ash geopolymer exposed to elevated temperatures. Results show that in the cases of $Na_2SiO_3/NaOH$ ratios of 2 and 2.5, the compressive strengths of geopolymers are decreased at all elevated temperatures except at 200^{o}C. However, significant improvement is noticed in the case of $Na_2SiO_3/NaOH$ ratio of 3, where the residual compressive strengths are increased up to 600^{o}C. Better results on the geopolymer synthesized with potassium based activators are obtained where the residual compressive strength up to 600^{o}C are much higher than their sodium based counterparts. The geopolymer containing K_2SiO_3/KOH ratio of 3 even gained about 5% strength at 800^{o}C. It is also found that the fly ash geopolymer synthesized with potassium based activators is more stable at elevated temperatures than its sodium based counterparts in terms of higher residual compressive strengths, lower mass loss, lower volumetric shrinkage and lower cracking damage. X-ray diffraction and thermogravimetric analysis results of sodium and potassium activator synthesized fly ash geopolymer also correspond to the measured residual compressive strengths.

Second part of this study presents the effects of two types of alkali activators (Na- and K-based) on the residual mechanical properties of steel fibre reinforced geopolymer concretes after exposed to various elevated temperatures and compared with those of steel fibre reinforced concrete. Results show that the steel fibre reinforced geopolymer concrete containing Na-based activators exhibited much higher residual compressive and indirect tensile strength at all elevated temperatures including at ambient condition than its K-based counterpart and steel fibre reinforced concrete. However, the retention of residual compressive strengths relative to ambient is comparable in both Na- and K-based steel fibre reinforced geopolymer concrete and both steel fibre reinforced geopolymer concretes showed original (ambient temperature) compressive strength retention capacity up to about 500^{0}C temperature. In the case of indirect tensile strength, the K-based steel fibre reinforced geopolymer concrete showed ambient temperature strength retention capacity up to about 700^{0}C temperature with more than 60% increase in residual indirect tensile strength at 400^{0}C. In the case of elastic modulus the steel fibre reinforced concrete, however, showed slightly higher retention capacity than the steel fibre reinforced geopolymer concrete. Good correlations between the indirect tensile strength and the compressive strength and between the elastic modulus and the compressive strength of all three types of fibre reinforced concretes are observed. Existing model to predict the compressive and indirect tensile strengths of steel fibre reinforced geopolymer concretes is found to underestimate the test results; however, it predicts reasonably well the elastic modulus of steel fibre reinforced geopolymer concretes. New empirical equations to predict the compressive, indirect tensile strength and elastic modulus of steel fibre reinforced geopolymer concretes are also proposed. Both steel fibre reinforced geopolymer concretes also show negligible damage in terms of surface cracking after elevated temperatures heating compared to visible surface cracks in steel fibre reinforced concrete.

Keywords: Geopolymer, fly ash, elevated temperatures, sodium, potassium activators, mechanical properties

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LIST OF ACRONYMS

AS	Australian Standard
ASTM	American Society of Testing Materials
CO_2	Carbon Dioxide
DTA	Differential Thermal Analysis
FRC	Fibre Reinforced Concrete
FRGC	Fibre Reinforced Geopolymer Concrete
K_2SiO_3	Potassium Silicate
KOH	Potassium Hydroxide
Na_2SiO_3	Sodium Silicate
NaOH	Sodium Hydroxide
OPC	Ordinary Portland Cement
SFRC	Steel Fibre Reinforced Concrete
SFRGC	Steel Fibre Reinforced Geopolymer Concrete
TGA	Thermogravimetric Analysis
XRD	X-Ray Diffraction
XRF	X-Ray Fluorescence

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LIST OF PUBLICATIONS

1. Hosan, A., Haque, S. and Shaikh, F. (2016) Compressive behaviour of sodium and potassium activators synthetized fly ash geopolymer at elevated temperatures: a comparative study.*Joournal ofBuilding Engineering*.(Accepted)

2. Shaikh, F.U.A. and Hosan, A. (2016) Mechanical properties of steel fibre reinforced geopolymer concretes at elevated temperatures. *Construction and Building Materials*. Vol. 114; 15-28.

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CHAPTER I

INTRODUCTION

1.1 Background

Concrete is one of the most commonly used construction materials in the world. The use of concrete is unavoidable in the future due to increasing world population and urbanisation. With the increasing population, infrastructures development is also increasing which leads the increasing consumption of concrete especially in the countries like China and India (Metha, 2001).

Ordinary Portland Cement (OPC) is used as the binding material of concrete which combines fine aggregates and coarse aggregates with the help of water to form concrete. The use of cement has increased to 3.6% in 2013 and expected to increase by 4% per year in recent future (http://www.cement.org). However, the environmental issues of OPC production are really of more concern as it is highly energy intensive. Each tonne of cement production release approximately one ton of carbon dioxide (CO_2) into the atmosphere which is alarming for global warming (Metha, 2001). Other research showed that the OPC production contributes about 1.6 billion tons of CO_2 which is about 5-7% of global loading of carbon dioxide (CO_2) emission into the atmosphere per year (Metha, 2001 and Malhotra, 2002). Since the global leaders are more concerned about global warming and clean environment for the future, it is obvious to find an alternative binding material for concrete.

Ordinary Portland Cement (OPC) concretes generally provide adequate fire resistance for most normal applications. However, the strength of OPC concrete decreases at elevated temperatures (Crozier and Sanjayan, 1999). Conventional concrete also spalls during exposure to fire. Small areas of concrete spall from the surface of the concrete as the temperature rises and expose the steel reinforcement to the fire and complete failure of the structure ultimately occurs (Sanjayan and Stocks, 1993).

This environmental awareness and structural failure due to fire has translated renewed interest in the technology of alkali activated alternative binder also known as geopolymer in construction industry. Geopolymer is an inorganic alumina-silicate polymer, synthesized from materials of geological origin that shows good bonding properties (Davidovits, 1991).The geopolymer binder is generally synthesized by reacting aluminate and silicate bearing source materials such as fly ash or metakaolin with alkali activator. Fly ash is an industrial by-product of coal burning power station and is available across the world, but its utilization is limited.Fly ash production will increase in the future and it is expected that by 2030 the production of fly ash would be about 2300 million of metric tons annually as shown in Fig. 1.1(Global Mining Conference, 2010). Moreover, the utilization of this industrial by-product as a concrete binder helps us to make the concrete environment friendly. For example, each million tons of fly ash replacement of OPC helps to conserve one million tons of lime stone, 0.25 million tons of coal and over 80 million units of power, notwithstanding the abatement of 1.5 million tons of CO_2 to atmosphere (Bhanumathidas and Kalidas, 2004).

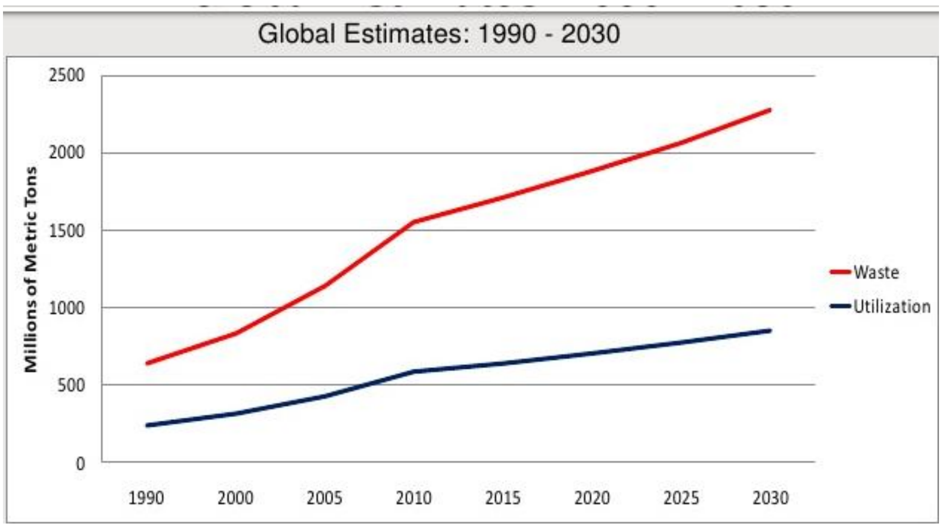


Figure 1.1 Fly Ash Production vs Utilisation (Global Mining conference, 2010)

The need for high compressive strength and increased service life of reinforced concrete structures led to the development of high performance concrete such as fibre reinforced concrete (FRC) in the last decades. FRC is widely used throughout the world because of its superior strength and ductility compared to the normal concrete. Different types of fibre are used to reinforce the concrete such as steel, carbon, basalt, polyvinyl alcohol (PVA) and others. Among many fibres steel fibres significantly improve the tensile and flexural strength, toughness and ductility of concrete. As a result steel fibre reinforced concrete (SFRC) is widely used in different construction applications, e.g. tunnel lining, airport pavement, impact and blast resistance of important structures. However, the above structures as well as other reinforced concrete structures experience fire hazards during their service life. During fire significantly high temperatures are developed around the structures which damage the concrete through cracking and spalling. In many studies polymeric fibres reinforced concrete shows spalling resistance at fire, however, its post fire residual mechanical properties is of great concern, as these fibres melt at elevated temperatures or lose their properties significantly if not melted. An advantage of steel fibre reinforced concrete (SFRC) at elevated temperatures during fire is their inherent higher melting temperature than the polymeric fibres, due to which the SFRC shows higher retention capacity of its original mechanical properties than its counterpart polymeric fibres reinforced concrete (Chen and Liu, 2004).

A number of studies are reported on the effect of elevated temperatures on mechanical properties and failure behaviour of SFRC. Poon et al. (2004) evaluated the effects of elevated temperatures of 600°C and 800°C on the compressive strength of SFRC. It is reported that the residual compressive strength of SFRC is about 50% of original after exposure to 600°C. At 800°C the residual compressive strength is 25%. Chen and Liu (2004) have also reported a similar study but in high strength concrete. They have reported that the residual compressive strengths of SFRC are about 90%, 60% and 38% of the original at 400°C, 600°C and 800°C, respectively. The authors also measured the residual tensile strengths (splitting) of above FRC and observed similar reduction.

In another study, Suhaendi and Horiguchi (2006) also reported similar rate of reduction in the compressive and tensile strengths of SFRC at 200°C and 400°C. In a recent study on steel FRC, Dugenci et al. (2015) reported about 78% to 96% reduction in the compressive strength of SFRC at 900°C to 1200°C temperatures. Kim et al. (2015) in their recent study also reported reductions in the compressive strengths of the SFRC at elevated temperatures.

Geopolymer is a sustainable binder which has been in research for last few decades (Davidovits, 1991). Research on geopolymer concrete has also gained momentum among concrete researchers due to its environmental friendliness and superior mechanical, durability and fire resistance properties than the ordinary concrete. However, unreinforced geopolymer concrete is still brittle with very low tensile and flexural strengths like the ordinary concrete. In a number of studies various fibres are added to geopolymer concrete to overcome this deficiency. Among various fibres, steel fibre showed significant improvement in the tensile and flexural strength of geopolymer concretes (Sayyad and Patankar, 2013 and Ganesan et al., 2013). Unlike regular concrete, the geopolymer concrete exhibits superior mechanical properties retention capacity at elevated temperatures during fire.

1.2 Research Significance

In the light of the above, a considerable research program has commenced to evaluate the effect of elevated temperatures on mechanical properties of steel fibre reinforced concrete (SFRC). Though there is sufficient evidence that geopolymer composite exhibits a better fire resistance, the study of mechanical properties of steel fibre reinforced geopolymer concrete (SFRGC) is still lacking and more research to be conducted to investigate the full potential of SFRGC at elevated temperatures. Limited researches have been conducted on carbon and cotton fibres reinforced geopolymer composites at elevated temperatures (Zhang et al. 2014 and Alomayri et al., 2014). Due to higher fire resistance of geopolymer matrix than the cement matrix, the SFRGC is expected to behave better than its counterpart SFRC.

This research presents the comparative behaviour of SFRC and SFRGC after exposure to elevated temperatures of 200^{0}C, 400^{0}C, 600^{0}C and 800^{0}C. The effects of two alkali activators namely sodium (Na) and potassium (K) based activators on the residual mechanical properties of SFRGC are also evaluated in this study. Experimental results are also compared with the predictions by existing empirical model for SFRC and Eurocode for concrete at elevated temperatures. Empirical equations to predict the residual mechanical properties of Na and K-based SFRGC, here in after termed as SFRGC(Na) and SFRGC(K), respectively, are also proposed based on the measured mechanical properties. In addition the cracking and failure behaviour of all SFRGC under ultimate compression is compared with SFRC and the changes of steel fibres in all three types of concretes after exposure to above elevated temperatures are also studied.

1.3 Research Aim and Objectives

The aim of this study is to evaluate the residual mechanical properties of steel fibre reinforced geopolymer concrete (SFRGC) and compare the results with its OPC counterpart steel fibre reinforced concrete (SFRC) after exposure to elevated temperatures. This study is divided into two parts. In first part, the effects of various alkali activator ratios on the properties of geopolymer synthesized by Na- and K-based activator are studied and the optimum ratio which exhibited the maximum residual compressive strength is used in the second part of this study.

To achieve this aim, the objectives of this study are to:

First part:

a) Evaluate the effect of different ratios of alkali activators on the compressive strength, volume and mass changes of fly ash geopolymer paste synthesized with the Sodium (Na) and Potassium (K) based alkali activators after exposure to elevated temperatures.

b) Evaluate the microstructure of fly ash geopolymer paste synthesized with Na and K-based activator through TGA and XRD analysis after exposure to elevated temperatures.

Second part:

a) Evaluate the residual compressive strength (f'c), tensile strength (ft) and elastic modulus (E) of SFRC and SFRGC after exposure to elevated temperatures.

b) Evaluate the effect of alkali activators namely Sodium (Na) and Potassium (K) based activators on the above properties of SFRGC after exposure to elevated temperatures and compare it with the properties of SFRC.

c) Evaluate the effect of steel fibre reinforcement on the residual mechanical properties of SFRC and SFRGC.

d) Evaluate the effect of alkali activators on the cracking and failure behaviour of the SFRGC after exposure to elevated temperatures and compare it with that of SFRC.

1.4 Scope of Work

In the first part of this experiment, the optimum ratio of silicate to hydroxide is selected which exhibited the highest residual compressive strength of geopolymer paste specimens among three different silicate to hydroxide ratios of Na- and K-based alkali activator after exposure to elevated temperature of 200°C, 400°C, 600°C and 800°C after 28 days of curing. The alkali activator to fly ash ratio was same for all the mixes of geopolymer paste. The microstructural changes of geopolymer paste after exposure to elevated temperatures are investigated through x-ray diffraction (XRD) and thermogravimetric analysis (TGA).In the second part of this experiment, this optimum silicate to hydroxide ratio is used to evaluate the residual mechanical properties such as compressive strengths, indirect tensile strengths and elastic modulus of steel fibre reinforced geopolymer concrete (SFRGC) and compared with the residual mechanical properties of steel fibre reinforced concrete (SFRC) after exposure to elevated temperatures of 200°C, 400°C, 600°C and 800°C. The volume of steel fibres was same for the each mixes of SFRGC and SFRC with constant water (alkali activator)/ cement (fly ash) ratio. The effect of steel fibres on the SFRGC was evaluated by adding extra amount of steel fibre on the both mixes of alkali activator. All the tests were performed after 28 days of curing in accordance with American Society for Testing and Materials (ASTM) and Australian standards.

1.4 Thesis Arrangement

This thesis report comprises five chapters as follows:

Chapter 1: This chapter presents the relevant discussion of this study including the background, significance, objectives and scope of this work.

Chapter 2: This chapter contains the brief review of literature on geopolymer, geopolymer concrete, fibre reinforced geopolymer concrete (FRGC), steel fibre reinforced geopolymer concrete (SFRGC).

Chapter 3: The details of materials used in this study, manufacture of test specimens, experimental methods including mixture proportions and testing methods to determine the mechanical properties of SFRGC discusses in this Chapter.

Chapter 4: This chapter presents and discusses the test results of the experimental works including compressive strengths, indirect tensile strengths, elastic modulus, mass loss, failure and cracking behaviour of SFRC, SFRGC.

Chapter 5: The conclusions of this experimental work and recommendation for further studies are given in this chapter.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter presents a brief review of geopolymer materials, geopolymer concrete, fibre reinforced concrete (FRC), fibre reinforced geopolymer concrete (FRGC) and steel fibre reinforced geopolymer concrete (SFRGC).

2.2 Geopolymer Materials

Geopolymer is a new construction material which has gained its popularity in recent years due to its environment friendliness and excellent mechanical, durability and fire resistant properties in severe environment. Geopolymer is first introduced by Davidovits (1991) and is generally synthetized by reacting aluminate and silicate bearing source materials with alkali activator. The hardening mechanism for geopolymers essentially involves the poly-condensation reaction of geopolymeric precursors, usually alumina-silicate oxides, with alkali poly-silicates yielding a polymeric silicon-oxygen-aluminium framework. Due to this inorganic framework, geopolymers are intrinsically fire resistant and have been shown to have excellent thermal stability, with very little gel structural degradation up to 700^{o}C to 800^{o}C. Excellent fire resistance of geopolymer is its most significant advantage over cement based binder.

Extensive researches have been conducted to study various mechanical and durability properties of geopolymer. Significant efforts have also been made by many researchers to study the effect of elevated temperatures on mechanical properties of geopolymer. However, most of the studies were on different geopolymers which were made by different types of source materials and alkali activators. Rickard et al. (2012) evaluated the physical characteristics of geopolymer synthesized from five different fly ashes using sodium silicate and sodium aluminate solutions before and after firing to 1000^{0}C. It is reported that geopolymers synthesised from fly ashes with a high

Si:Al (≥5) exhibited compressive strength gains and greater dimensional stability upon exposure to 1000°C, whereas geopolymers synthesised from fly ashes with low Si:Al (<2) exhibited strength losses and reduced dimensional stability upon high temperature exposure.

Abdulkareem et al. (2014) presented the characteristics of fly ash geopolymer paste and mortar activated by sodium based activator after exposure to elevated temperature to 800ᵒC and reported all geopolymers after exposure to the elevated temperatures underwent a strength deterioration which was developing with increasing the elevated temperature and addition of aggregates improve the fire resistance of geopolymer mortar.

Ranjbar et al. (2014) studied compressive strength of fly ash (FA)/palm oil fuel ash (POFA) based geopolymer mortar activated by combination of sodium silicate and sodium hydroxide solution under elevated temperature. All of the FA/POFA based geopolymer mixtures gained strength when exposed to temperatures up to 500ᵒC compared to the specimens which were not subjected to elevated temperatures; however, increasing the FA content results in the highest compressive strength at 300ᵒC. On the other hand, increasing in POFA content delays the temperature of maximum strength. Meanwhile, all of the specimens lost strength when exposed to temperatures above 500ᵒC.

A recent study (Shaikh et al., 2015) of the compressive strength of fly ash based geopolymer concrete activated by sodium based activator at elevated temperatures of 200ᵒC, 400ᵒC, 600ᵒC and 800ᵒC reported that the fly-ash-based geopolymer concretes exhibited steady loss of its original compressive strength at all elevated temperatures up to 400 °C regardless of molarities and coarse aggregate sizes. At 600°C, all geopolymer concretes exhibited increase of compressive strength relative to 400°C. However, it is lower than that measured at ambient temperature. Similar behaviour is also observed at 800°C, where the compressive strength of all geopolymer concretes are lower than that at ambient temperature.

Kong and Sanjayan (2008) investigated the damage behaviour of geopolymer composites made with class F fly ash activated by combined sodium silicate and potassium hydroxide solution after exposure to elevated temperature. It is reported that fly ash to activator ratio is the most critical parameter with regards to general strength and fire resistance of the geopolymer paste. Within the composition studied, the optimal composition combination for elevated temperature performance achieved with Na_2SiO_3/KOH=2.5 and FA/activator=3.0 and after several study conducted it has shown that fly ash based geopolymer displayed increase in strength after exposure to elevated temperatures.

Kong and Sanjayan (2010) studied the effect of elevated temperatures on fly ash based geopolymer paste, mortar and concrete synthesized by combined solution of sodium silicate and potassium hydroxide. The study found that aggregate size is one of the main factors that govern geopolymer behaviour at elevated temperatures (800^{o}C). Smaller size aggregates (<10 mm) promote spalling and extensive cracking in the geopolymer concrete while geopolymer concretes containing larger aggregates (> 10 mm) are more stable in elevated temperatures.

Another study (Bakharev, 2006) concluded that the thermal stability of the fly ash geopolymer materials prepared with sodium-containing activators was rather low and rapid deterioration of strength at 800 °C was observed. It is also reported that materials prepared using fly ash and potassium silicate had better thermal stability than geopolymers prepared using Na-containing activators, materials remained mostly amorphous up to 1200^{o}C. Geopolymer materials prepared using class F fly ash and sodium and potassium silicate show high shrinkage as well as large changes in compressive strength with increasing fired temperature in the range 800^{o}C to 1200°C also observed in that study.

Guerrieri and Sanjayan (2010) have studied the behaviour of combined fly ash/slag based geopolymer activated by sodium based activator after exposure to high temperatures. The study concluded that the residual compressive strength performance at 800^{o}C is influenced by the initial strengths of the specimens. The specimens with very low initial strengths *(*<7.6 MPa*)* experienced an increase in residual strength after exposure to 800°C and up to 90% gain. Specimens with initial strengths in the order of 28MPa had residual strength losses of approximately 70%, while specimens with higher initial strengths approaching 83 MPa had residual strength losses in the order of 90% after exposure to 800°C.

Kong et al. (2007) investigated the effect of elevated temperatures on geopolymers manufactured using metakaolin and fly ash of various mixes proportions. Both types of geopolymers (metakaolin and fly ash) were synthesized with sodium silicate and potassium hydroxide solutions. Both types of geopolymers were subjected to thermogravimetric, scanning electron microscopy and mercury intrusion porosimetry tests and it is found that the strength of the fly ash-based geopolymer increased after exposure to elevated temperatures (800°C). However, the strength of the corresponding metakaolin-based geopolymer decreased after similar exposure.

Based on above researches, it can be concluded that among all above source materials the class F fly ash is rich in silica and alumina and low in calcium oxide, which enables its higher stability at elevated temperature in fire than others. Moreover, it is cheaper, easily and widely available than other source materials.

2.3 Behaviour of Fibre Reinforced Concrete (FRC) at Elevated Temperatures

Fibre reinforced concrete (FRC) has been developed over the last few decades. The primary reason of addition of fibres in concrete is to improve its tensile and flexural strengths and post-cracking ductility.

Eziane et al. (2011) showed that steel fibres limit the cracking during exposure to fire and control the spread of cracks during mechanical loading. The polypropylene fibres melted at 170˚C thus created porosity which limited the pore pressure due to evaporation of pore water at fire; consequently reduced the spalling of concrete. The hybrid fibre reinforced (combined of steel and polypropylene fibres) mortars offered good compromise: the polypropylene fibres reduced the internal pressure that reduced the cracking at elevated temperatures and steel fibres reduced the cracking during heat exposures and under subsequent mechanical loading.

Cavdar (2011) concluded that the flexural strength of the OPC mortars reduced at elevated temperatures. However, the addition of fibres slightly improved the flexural strength. In this study, four different types of fibres namely; Polypropylene (PP), carbon (CF), glass (GF) and polyvinyl alcohol (PVA) were added to cement mortars to investigate their contribution to flexural strength of mortar under elevated temperatures. These fibres were added into mortars in five different ratios (0.0%, 0.5%, 1.0%, 1.50% and 2.0%) by volume. The mortars were subjected to the following temperatures: 21˚C (normal conditions), 100˚C (oven dry), 450˚C and 650˚C. The flexural strengths of non-fibrous mortar have decreased by 76% and 87% at 450˚C and 650˚C respectively. However, these reductions for fibrous mortars are at about 60% at 450˚C and about 88% at 650˚C. All fibres contributed to the flexural strengths of mortars at elevated temperatures. The samples with PVA showed the best flexural performance (75% to 150%) under high temperatures. The compressive strengths of non-fibrous mortar have decreased by 20% at 450˚C and about 53% at 650˚C. These reductions for PP and GF reinforced mortars were about 40% to 50% at 450˚C and about 55% to 70% at 650˚C. However, for CF and PVA these reductions were about 3% to 8% at 450˚C and 50% to 60% at 650˚C. The highest increase in flexural strength and the lowest decrease in compressive strength are at 0.5% to 1.5% for CF, 0.5% for PP and GF and 0.5% to 1.5% by volume if all temperature conditions are taken into consideration.

Lau and Anson (2006) studied the effect of high temperature on the performance of steel fibre reinforced concrete. A temperature range of 105^{0}C and 1200^{0}C was considered and compressive strength, flexure strength, modulus of elasticity, porosity and change of colour of hardened concrete were investigated. For the study, steel fibres of 1% volume fraction were considered. It was observed that compressive strength decreases with the increases of temperatures. It was further observed that at 400^{0}C, the decrease in compressive strength is not significant, but above 400^{0}C, there is a considerable decrease in strength. The study also reported that normal strength concrete shows better strength at 600^{0}C than high performance concrete. It was concluded that the presence of steel fibres arrest spalling and cracks which contributed better mechanical strength at elevated temperatures.

Chen and Liu (2004) evaluated the effect of elevated temperatures ranges from 200ºC to 800ºC on the mechanical properties of steel fibre reinforced concrete (SFRC). In this study, 0.6% volume fraction of steel fibre used to investigate the residual compressive strength and residual splitting tensile strength. It is found that residual compressive strengths of SFRC are approximately 90%, 60% and 38% of the original at 400ºC, 600ºC and 800ºC, respectively. It is also concluded that reduction of splitting tensile strengths of SFRC after exposure to elevated temperatures are same as reduction of compressive strengths and adding of steel fibres in high strength concrete can delay the time of spalling under elevated temperatures.

In another study, Giaccio and Zerbino (2005) studied the residual mechanical behaviour of thermally damaged high strength steel fibre reinforced concrete after two types of exposure to elevated temperature; 1 hour at 500ºC and 24 hours at 150ºC. For this study, residual compressive strength and elastic modulus were investigated and found that there is no such reduction of compressive strengths after exposure of 150ºC temperature while residual elastic modulus were varied from 90% to 82%. It was also found that residual compressive strengths of SFRC were about 60% to 70% at 500ºC while elastic modulus reduced to about 40% to 60% of its original strength of different type of high strength concrete.

Peng et al. (2006) experimentally investigated the relation between explosive spalling occurrence and residual mechanical properties of steel fibre toughened high performance concrete exposed to high temperatures ranged from 200ºC to 800ºC. The specimens were then heated in an electric furnace to temperatures of 400ºC, 600ºC and 800 °C, respectively, at a heating rate of 10 °C/min. The target temperatures were maintained for 1 hour. The residual mechanical properties measured include compressive strength, tensile splitting strength and fracture energy. After the series of concrete preparation and testing, it is concluded that although residual strength was decreased by exposure to high temperatures above 400°C,residual compressive strength of SFRC was about 90% of original after exposure to 600ºC. At 800ºC the residual compressive strength was 40%. In this study, it is also concluded that residual tensile splitting strength was 80% of its original at 400ºC and steel fibre may be beneficial to help concrete overcome vapour pressure build-up under high temperatures and hence avoid occurrence of spalling.

Recent experiment from Kim et al. (2015) evaluated the mechanical properties of steel fibre reinforced concrete exposed to different elevated temperatures of 300°C, 500°C and 700°C. Two types of steel fibre namely twisted and hooked with a volume of fraction of 0.25%. 0.50% and 1% were used in this study. Compressive strength test and tensile strength test were performed to calculate the residual mechanical properties of SFRC after exposure to elevated temperatures. It is reported that a significant loss of strength occurred above 300°C. The residual compressive strengths of SFRC heated to 300°C, 500°C, and 700°C were respectively about 92%, 60%, and 30% of the value at the room temperature. It was also found that there is a steady loss in tensile strength with an increase in temperature. The tensile strength of the SFRC specimens heated at 300°C, 500°C, and 700°C were respectively about 75% to 65%, 65% to 39%, and 46% to 22% compared to the value before heating.

2.4 Fibre Reinforced Geopolymer Concrete

Geopolymer has recently been emerged as a novel binder with superior mechanical and durability properties than conventional cement based binder (Duxson et al., 2007). Geopolymer is a term used to describe inorganic polymers based on aluminosilicate and can be produced by synthesizing pozzolanic compounds or aluminosilicate source materials with highly alkaline solutions (Davidovits, 1991 and Davidovits, 1993). Due to their ceramic-like properties, geopolymers possess good fire resistance compared to conventional concrete produced with OPC (Davidovits, 1991 and Cheng and Chiu, 2003). Generally, geopolymer concrete exhibits better compressive strength than OPC concrete (Rangan, 2007) and the flexural strengths of fibre reinforced geopolymer concrete (FRGC) are also increased with the addition of fibres reported in different studies on FRGCs (Bernal et al., 2010, Puertas et al., 2003 and Zhang et al., 2009).

Zhang et al. (2014) studied the development of fibre reinforced metakaolin-fly ash based geopolymers for fire resistance application. Geopolymer specimens with different content of chopped carbon fibre and fly ash were prepared and undertaking bending and compression tests. Five combinations of FA/ (MK+FA) with mass ratios of 0, 20%, 50%, 75% and 100% and four different mass contents of 0, 0.5%, 1% and 2% of chopped CF to MK-FA precursor were considered for the investigation in this study. For undertaking bending and compression tests, the specimens were first heated to target temperature in an electric furnace, at a heating rate of 5°C per minute and specimens were kept at the peck temperature for 60 minutes to attain thermal stability. It is found that addition of chopped carbon fibres in geopolymers provide effective crack control under high temperature exposure in 20°C to 500°C temperature range. It is also found that addition of chopped carbon fibres in geopolymer does not significantly influence compressive strengths of geopolymers in 20°C to 700°C. The authors also evaluated that geopolymer with higher fly ash and lower metakaolin content exhibit greater retention rate after exposure to high temperature and geopolymer consisting of 50% fly ash and 50% metakaolin and 2% carbon fibres provides optimum bending and compressive strength properties at ambient temperature and after exposure to high temperature.

In a recent study (Alomayri et al., 2014) studied the mechanical properties of cotton fabric reinforced geopolymer composites at different temperatures ranging from 200°C to 1000°C. Mechanical properties such as flexural strength, compressive strength and fracture toughness were evaluated. In this study, alkaline solution to fly ash weight ratio was fixed at 0.35, whereas the weight ratio of sodium silicate solution to sodium hydroxide solution was maintained at 2.5. Composites samples with different fibre content of 0, 4.5 wt%, 6.2 wt% and 8.3 wt% were heated with a rate of 5°C/min until the target temperatures were reached and hold for 2 hour at target temperatures. It is shown that compressive strength, flexural strength and fracture toughness all decrease after exposure to high temperatures (200°C to 600°C) and a severe loss in strength was observed on specimens heated at 800°C and 1000°C.

In another study (Rickard et al., 2012), physical characteristics of metakaolin based geopolymers reinforced with polypropylene fibres were investigated. Samples with densities between 0.7 and 1.0 g/cm^3 and average compressive strengths between 4.4 and 9.5 MPa were achieved. The fire rating of the samples was at least 60 min. The best performing sample was the un-foamed geopolymer which had a fire rating of 97 min. This study also found that foaming the samples reducing their thermal conductivity but did not improve their ability to insulate during a fire due to their lower water content. The sample with 0.02 wt% aluminum was the best performing of the foamed samples as it achieved a fire rating only 15 min less than the un-foamed sample. This study reported that foamed geopolymers have good potential in ambient applications including their use as an insulator or as a light weight building material.

Bernal et al.(2011) assessed the mechanical performance of metakaolin (MK) based geopolymer composites reinforced with recycled refractory brick particles and high alumina fibres, after exposure to elevated temperatures. In this study, particle reinforced composite and particle/fibre reinforced composites were analysed; the compressive and flexural strengths were measured after the exposure of the specimens to temperatures between 600˚C and 1000˚C, and compared with the volumetric concentration of the unreinforced matrix. The analysis data revealed that the inclusion of refractory particles, both with and without additional refractory fibres, improved post-exposure compressive and flexural strengths compared to samples without reinforcement. Specimens exposed to temperatures between 600˚C and 1000˚C exhibited reduced shrinkage with the inclusion of higher contents of particles and fibres, while retaining good mechanical strength.

In a very recent study, Samal et al. (2015) investigated the effect of various fibres reinforced in a geopolymer matrix at elevated temperatures. Three different types of fibres such as carbon, E-glass and basalt fibres were used to signify the improved performance geopolymer as a function of physical, thermal, mechanical and heat resistant properties at elevated temperatures. In this study, geopolymer matrix was prepared with metakaolin, alumina-silicate powder and alkali activator NaOH/KOH content ratio of 15.6. The heat testing was performed in a electric furnace with radiant heat of 25 kW/m² from the temperature 200^{0}C to 1000^{o}C on the samples of (3 × 14 × 90) mm panels with fibre incorporation of 39 to 41 vol. %. It is concluded that at elevated temperatures, carbon reinforced geocomposite exhibited higher strength and better homogeneity can be used as a fire resisting panels in industrial fields at elevated temperatures.

2.5 Steel Fibre Reinforced Geopolymer Concrete (SFRGC)

Past studies on fibre reinforced geopolymer concrete after exposure to elevated temperatures are extremely limited. Most of the past studies were based on metakaolin based geopolymer concrete reinforced with carbon fibres, polypropylene fibres, reinforced with recycled refractory brick particles and high alumina fibres. All the above studies have shown that inclusion of fibre improved compressive and flexural strength after exposure to the fire compared to the samples without fibre.

Though there is sufficient evidence that steel fibres have the advantage at elevated temperatures during fire due to their inherent melting temperature over any other fibre. Therefore, SFRC has the higher retention capacity of mechanical properties after exposure to elevated temperatures. There is no sufficient evidence of the behaviour of steel fibre reinforced geopolymer concrete of elevated temperatures.

CHAPTER III
METHODOLOGY

3.1 Introduction

This chapter describes in detail the properties of materials used in this experimental work, mix proportions, specimens preparation and the test methods of measuring various properties of the geopolymer paste and concrete of this experiment. Details of specimens preparation and various test methods of geopolymer paste cubes to select the appropriate ratios of alkali activators to have the maximum residual mechanical properties of the fly ash geopolymer paste for each alkali activator (sodium and potassium) after exposure to elevated temperatures are also explained. This chapter also discusses the manufacture of specimens and test methods of steel fibre reinforced concrete (SFRC) and steel fibre reinforced geopolymer concrete (SFRGC) containing Na- and K-based activators to evaluate the residual mechanical properties after exposure to elevated temperatures. All the specimens manufacturing and test methods are performed according to specification of American Society for Testing Materials (ASTM) standards. A brief discussion of microstructural analysis of geopolymer paste such as X-ray diffraction (XRD) and thermogravimetric analysis (TGA/DTA) are also discussed in this chapter.

3.2 Materials

3.2.1 Fly Ash

In this study, the low calcium (ASTM Class F) dry fly ash supplied by Gladstone power station of Queensland was used as the source material to prepare the geopolymer pastes. The Table 3.1 shows the breakdown of its chemical compositionexamined by using X-Ray Fluorescence (XRF) test.

Table 3.1 Chemical Composition of Fly Ash (mass%)

Compounds	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	TiO_2	MgO	P_2O_5	SO_3	TiO_2	MnO	LOI*
Fly ash	51.11	25.56	12.48	4.3	0.77	0.7	1.57	1.45	0.885	0.24	1.32	0.15	0.57

*Loss on ignition

3.2.2 Alkaline Solutions

The activating alkali liquids consisted of Na_2SiO_3 and NaOH solutions as well as K_2SiO_3 and KOH solutions. The Na-based activator was composed of 8.0 M sodium hydroxide (NaOH) and D Grade sodium silicate (Na_2SiO_3) solutions. NaOH solution was prepared with a concentration of 8.0M by mixing 320 g of NaOH pallets into tap water to make 1 litre of solution. The solid NaOH pellets were a commercial grade with 97% purity. The D Grade Na_2SiO_3 solution was supplied by PQ Australia with a specific gravity of 1.51 and a modulus ratio (Ms) equal to 2.0 (where Ms = SiO_2/ Na_2O, Na_2O = 14.7% and SiO2 = 29.4%). The NaOH and Na_2SiO_3 solutions were mixed together with Na_2SiO_3/NaOH mass ratio of 2, 2.5 and 3 to prepare the Na-based activators.

The K-based activator was composed of 8.0M potassium hydroxide (KOH) and potassium silicate (K_2SiO_3) solutions. KOH solution was prepared with a concentration of 8.0M solution by mixing 448.8 g of KOH flakes of 90% purity supplied by Perth Scientific, Australia and tap water to make 1 L of solution. The K_2SiO_3 (KASIL 2236 Grade) solution was supplied by PQ Australia with a specific gravity of 1.32 and a modulus ratio (Ms) equal to 2.23 (where Ms = SiO_2/K_2O, K_2O = 11.2% and SiO_2 = 24.8%). KOH and K_2SiO_3 solutions were mixed together with K_2SiO_3/KOH mass ratio of 2, 2.5 and 3 to prepare the K-based activators. For the concrete specimens, the silicate to hydroxide ratio of 3 in both alkali activators was selected based on the analysis of geopolymer paste specimens discussed in the next chapter IV.

3.2.3Ordinary Portland Cement

In this experiment, the ordinary portland cement (OPC) type I was used to cast the cylinder specimens for SFRC, manufactured by Swan cement with the specific gravity 2700 to 3200 kg/m³ and 25% to 40% of particles are ≤ 7μm size. The physical properties and chemical composition of ordinary portland cement (OPC) is shown in Table 3.2.

Table 3.2 Physical properties and Chemical Composition of OPC

Compounds	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	MgO	SO_3	LOI*	Paricle size	Specific gravity
OPC (wt. %)	20.20	4.90	2.80	63.90	-	2.0	2.4	2.4	25-40% ≤ 7μm	2.7 to 3.2

*Loss on ignition

3.2.4 Aggregates

In this study, natural river sand was used as the fine aggregate and granite rocks of 10mm and 20mm sizes were used as coarse aggregates to cast cylinders of SFRC and SFRGC. All the aggregates were treated to achieve saturated surface dry (SSD) condition by soaking water for 24 hours and then wiping the surface by a trowel were prepared to meet the requirements given by the relevant ASTM standards ASTM C128 and ASTM C127.

3.2.5 Fibres

The steel fibre used in this study was hooked end with 60 mm in length and 0.9mm in diameter. The tensile strength of steel fibre was 1250 MPa.

3.2.6 Superplasticizer

A naphthalene sulphonate based superplasticizer named Rheobuild 1000 was used to improve the workability of the concrete mixtures. The amount of superplasticizer was used to maintain the consistency and workability of concrete mixtures.

3.3 Experimental Program and Mix Proportions

3.3.1 Geopolymer Pastes

The experimental program is consisted of two parts. The first part is geopolymer paste containing sodium based activators combinations, where three different sodium silicate to sodium hydroxide ratios of 2, 2.5 and 3 are considered and for each ratio the geopolymers are heated at 200^{o}C, 400^{o}C, 600^{o}C and 800^{o}C temperatures as well as at ambient temperature. Thus fifteen series of pastes are cast and tested after exposure to elevated temperatures in the first part to determine the effects of various alkali activator ratios on the geopolymer properties and evaluate the optimum ratio which exhibited the maximum residual compressive strength.

The second part is similar to the first part in every aspect except the alkali activators where potassium silicate and potassium hydroxide are used. For each series, in both parts, six 50 mm cube specimens are cast and tested after 28 days of curing according to ASTM standard and the average value is shown in the results. Detail experimental program and mix proportions can be seen in Table 3.3. In all pastes a constant activators/fly ash ratio of 0.35 is considered.

Table 3.3 Experimental program and mix proportions

Part 1				Part 2			
Sample ID	Na_2SiO_3/NaOH	Activators/fly ash	Kiln Temperature	Sample ID	K_2SiO_3/KOH	Activators/fly ash	Kiln Temperature
Na-2-28	2	0.35	Ambient	K-2-28	2	0.35	Ambient
Na-2-200	2	0.35	200	K-2-200	2	0.35	200
Na-2-400	2	0.35	400	K-2-400	2	0.35	400
Na-2-600	2	0.35	600	K-2-600	2	0.35	600
Na-2-800	2	0.35	800	K-2-800	2	0.35	800
Na-2.5-28	2.5	0.35	Ambient	K-2.5-28	2.5	0.35	Ambient
Na-2.5-200	2.5	0.35	200	K-2.5-200	2.5	0.35	200
Na-2.5-400	2.5	0.35	400	K-2.5-400	2.5	0.35	400
Na-2.5-600	2.5	0.35	600	K-2.5-600	2.5	0.35	600
Na-2.5-800	2.5	0.35	800	K-2.5-800	2.5	0.35	800
Na-3-28	3	0.35	Ambient	K-3-28	3	0.35	Ambient
Na-3-200	3	0.35	200	K-3-200	3	0.35	200
Na-3-400	3	0.35	400	K-3-400	3	0.35	400
Na-3-600	3	0.35	600	K-3-600	3	0.35	600
Na-3-800	3	0.35	800	K-3-800	3	0.35	800

3.3.2 Steel Fibre Reinforced Geopolymer and OPC Concrete

The experimental work was divided into three series of mixing of concrete. First series was SFRC as control containing 100% OPC. The second and third series were SFRGC containing sodium and potassium based activators, respectively with 100% replacement of cement by Class F fly ash. At least three standard cylinders were cast for each temperature exposed for compressive strength, elastic modulus and indirect tensile strength test. All the specimens were cured for 28 days before exposure to elevated temperatures. The total volume fraction of steel fibre was kept the same in all three series. In all series a constant water (or alkali activator)/binder ratio of 0.4 was considered. Super plasticizer was added to the mixes of SFRGC containing sodium based activator to maintain adequate workability. The detail mix proportions of all three series are shown in the Table 3.4.

Table 3.4 Experimental program and mix proportions

Series	Mix Proportions in kg/m³									Added Super-Plasticizer	Steel Fibre (Vol. %)	Water/ Cement Ratio	Alkali activator/ Fly Ash ratio
	Cement	Fly Ash	Sand	Coarse aggregate(mm)		Alkali Activator							
				10	20	NaOH	Na_2SiO_3	KOH	K_2SiO_3				
1-SFRC	408	-	660	467	701	-	-	-	-	-	0.5	0.4	-
2-SFRGC(Na)	-	408	660	467	701	41	122	-	-	150g	0.5 and 0.75	-	0.4
3-SFRGC(K)	-	408	660	467	701	-	-	41	122	-	0.5 and 0.75	-	0.4

3.4 Specimen Manufacture and Curing Process

3.4.1 Geopolymer Paste Specimens

All geopolymer pastes were prepared in a Hobart mixer which is shown in the Fig. 3.1 at an ambient temperature of approximately 23°C with alkali activator/fly ash ratio of 0.35. To prepare the Na and K-based geopolymer paste dry fly ash were mixed in Hobart mixer for approximately 2 to 3 minutes with high speed. Then the alkaline activators in the form of solution were added to the fly ash and mixed for another about 2 to 3 minutes.

Figure 3.1 Hobart Mixer

The fresh geopolymer pastes were cast into standard 50 mm plastic cube moulds and compacted using a vibrating table. The specimens were subjected to heat curing. In this regard, all moulds were sealed to minimize moisture loss and placed in an oven at 70°C for 24 hour as shown in Fig. 3.2. At the end of heat curing period, the specimens were removed from the oven and kept undisturbed until being cool and then removed from the moulds and left in the laboratory at ambient temperature for 28 days.

Figure 3.2 Oven for curing of paste specimens

3.4.2 Steel Fibre Reinforced Geopolymer and OPC Concrete

The mixing of fibre reinforced concretes was carried out in a pan mixer. First, the coarse aggregates, sand in saturated surface dry condition and cement (or fly ash in the case of geopolymer concrete) were dry mixed for approximately 4 to 5 mins due to higher volume of mix and presence of coarse aggregates, and then, water (or alkali activator) was slowly added into the mix and continued to mix for another 4 to 5 mins. The fibres were then added gradually and mixed continually until uniform dispersion of fibres were observed in the mix. Super plasticizer was added to the mix of SFRGC (Na) concrete. The slump of every series of concrete was also measured in order to observe the consistency of the mixtures according to ASTM C143 standard. Immediately after mixing, the fresh concrete was cast into the cylinders. All the compressive strength test cylinders were cast in two layers and the cylinders for indirect tensile strength were cast in three layers.

Figure 3.3 Cylinders mould after compaction

Each layer of concrete compacted on a vibrating table shown in Fig. 3.3 and then SFRC cylinders were kept in laboratory at room temperature and cylinders for SFRGC placed inside the steam curing chamber (Fig. 3.4) and cured at 60°C for 24 hours. To maintain the temperature inside the steam-curing chamber, the solenoid valve complete with digital temperature controller and thermocouples were attached to the boiler installation system and placed inside the sheet of plastic to cover the concrete cylinder specimens to avoid condensation. The digital controller automatically opened the solenoid valve to deliver the steam into the chamber and closed after desired temperature was achieved.

Figure 3.4 Steam Boiler System

The SFRC cylinders were demoulded after 24 hours and cured in water for 28 days at room temperatures. The SFRGC cylinders were removed from the chamber and left to the air-dry at room temperature for another 24 hours before demoulding and then the test specimens were kept in the laboratory at room temperature for 28 days. Before putting the specimens in the kiln, they were dried in an oven at 105°C for 24 hours to remove any free water from the concrete. This is to prevent the specimens from exploding in the kiln during the heating process, as a result of extremely high pore water pressure from the superheated water. To cast the concrete specimens for compressive strength and elastic modulus, steel cylindrical moulds of 200 mm in height and 100 mm in diameter were used, whereas to measure indirect tensile strength steel cylinders of 300 mm in height and 150 mm in diameter were used. At least three cylinders were cast and tested for each series and for each temperature. Some cylinders were modified in order to install 20 mm long and 2 mm diameter removable pins so that holes would be cast into the specimens for the thermocouples to be installed.

3.5 Elevated Temperature Exposure

A locally manufactured kiln was used to heat the specimens, where the specimens were heated up to 800°C. The heating rate of 5°C/min was applied as this was the maximum rate could be achieved in the kiln. To monitor the temperatures, four 'type K' thermocouple shown in Figs. 3.5 to 3.6 were set up in different positions inside the kiln and in the cylinders and on the cubes. Two thermocouples were set up to monitor the air temperature inside the kiln. One was positioned 50 mm from the top of the interior, and another was set 50 mm from the bottom of the kiln. Among the remaining two thermocouples one was inserted in to a sacrificial cylinder to monitor the core temperature of the cylinder sample, while the other was placed on the surface of the cylinder. In the case of cube specimens, two thermocouples touched the cubes.

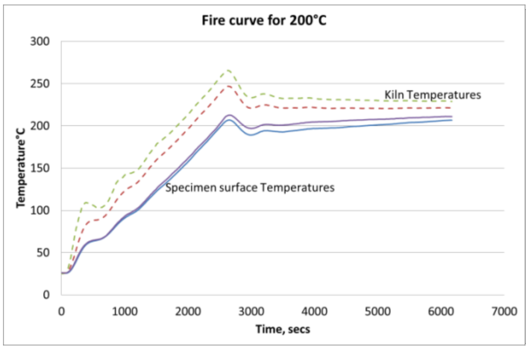
Figure 3.5 Geopolymer specimens inside the kiln.

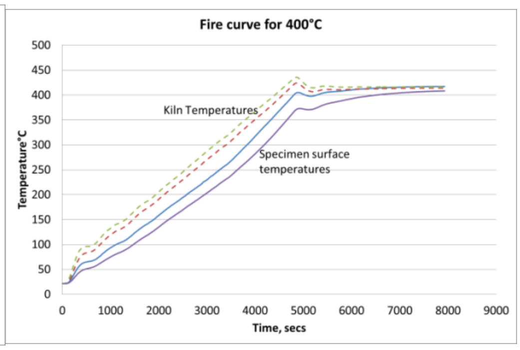
Figure 3.6 Position of Thermocouples inside the kiln and in the cylinder.

The thermocouples were connected to the data logger and were used to monitor the temperature inside the concrete and the kiln air as shown in Fig. 3.7. A heating rate of 5°C per minute was selected, which is very close to the RILEM recommended heating rate (RILEM TC 129-MHT, 2009). During heating process the temperatures of four thermocouples were monitored. Once the specimen’s surface reached the target temperature, the temperature inside the kiln was held for one hour.

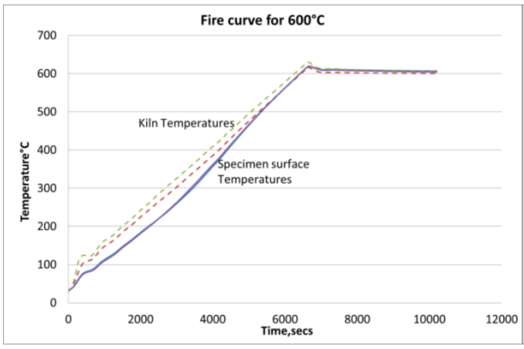
Figure 3.7 Data logging instrumentation with kiln.

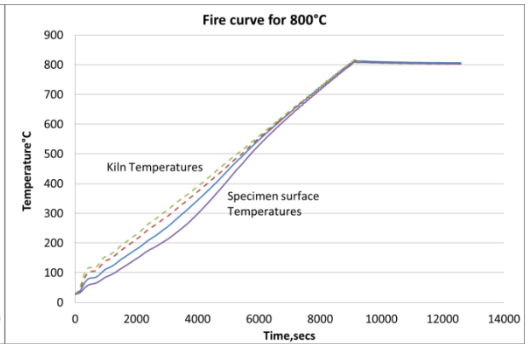
The rate of temperature increase in the kiln and in the cube and cylinder specimens is shown in Figs. 3.8 to 3.9. As can be seen in the figure, there is a significant lag between the surface temperature of cubes and air temperature inside the kiln, particularly for the cubes at 200°C and for concretes at 200°C and 400°C temperature profiles. This is due to the heat capacity of the specimens and the rate at which they are able to absorb heat. However, the difference in temperature between the kiln and the cubes at 400°C, 600°C and 800°C is less. Even though the difference in temperature between the kiln and the cubes existed, the target test temperatures in all cubes were maintained for one hour, which can be seen in the cubes thermocouples readings in Fig. 3.8.





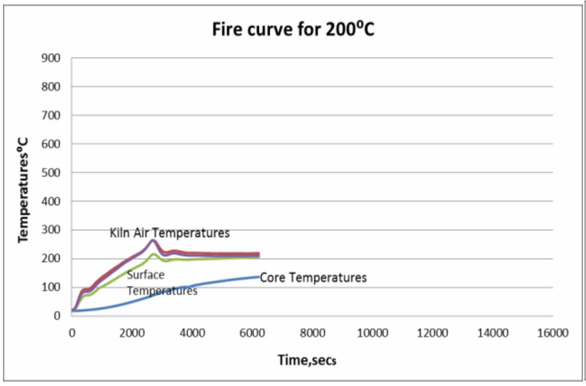
(a) (b)

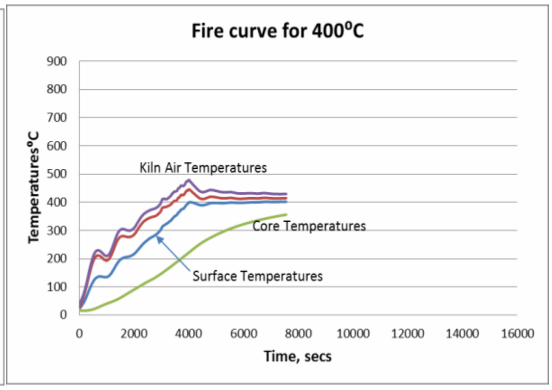




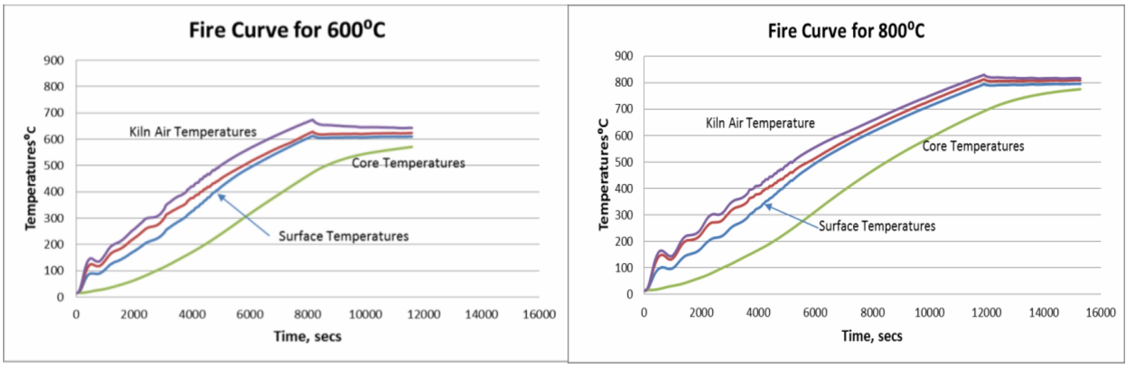
(c) (d)

Figure 3.8 Temperature profiles of cubes specimens for different elevated temperatures in the kiln during heating.





(a) (b)



(c) (d)

Figure 3.9 Temperature profiles of cylinders for different elevated temperatures during heating.

3.6 Test Methods

3.6.1Geopolymer Cube Specimens

Compressive strength of all geopolymer cube specimens was carried out using multifunctional control console machine (MCC8) according to ASTM C109 with a loading rate of 0.7 MPa/sec. The setup for this test is shown in the Fig. 3.10. For each mix, at least six specimens were tested in order to check the variability of performance under compression. Small portion of broken samples were kept to perform X-ray diffraction (XRD) and thermal (TGA/DTA) analysis. The volume stability or in other words the volumetric shrinkage of pastes was determined by measuring the length of three sides of the cubes before and after heating at respective elevated temperatures. The difference in volume changes indicates the shrinkage and six specimens were used to measure the shrinkage for each series. Similar method was used to determine the mass loss of geopolymer pastes after exposed to respective elevated temperatures.

Figure 3.10 Compressive strength test setup for paste specimen

3.6.2 Thermal Characterization (TGA/DTA)

The thermal stability of samples was studied by thermogravimetric analysis (TGA). A Mettler Toledo TGA one star system analyser was used for all these measurements. Samples of 25 mg were placed in an alumina crucible and tests were carried out in Argon atmosphere with a heating rate of 10^{o}C/min from 25^{0}C to 1000^{o}C.

3.6.3 X-ray Diffraction

In the case of XRD analysis, the powder of geopolymer paste samples were prepared and submitted for XRD analysis. The samples were measured on a D8 Advance Diffractometer (Bruker-AXS) using copper radiation and a Lynx Eye position sensitive detector. The diffractometer were scanned from 7^o to 70^o (2θ)in steps of 0.015^o using a scanning rate of 0.5^o/min. XRD patterns were obtained by using Cu Ka lines (k = 1.5406 Å). A knife edge collimator was fitted to reduce air scatter.

3.6.4 Mechanical Properties of SFRC and SFRGC

3.6.4.1 Compressive Strength Test

The compressive strength test of SFRC and SFRGC containing Na- and K-based activators were performed by using multifunctional control console machine (MCC8) after 28 days of ambient condition and after exposure to different elevated temperatures according to ASTM C39 standard using a loading rate of 0.33 MPa/sec. For each series and temperature, three specimens were tested and the average value of these strengths is reported in this experiment. The specimen setup for this compressive strength test is shown in Fig. 3.11.

Figure 3.11 Compressive strength test setup for concrete specimens.

3.6.4.2 Tensile Strength Test

The tensile strength test of SFRC and SFRGC containing both Na- and K-based activator were carried out by using MCC8 as well which meets the requirement of ASTM C 39/C 39M after exposure to different elevated temperatures and ambient temperature samples as well. The cylinder was placed on its side and subjected to a diametric compressive force along its length. The loading rate using in this test was according to ASTM C 496 standard of 0.067 MPa/sec. The failure of the cylinders occurred along a vertical plane containing the specimen axis and the applied load shown in Fig. 3.12.

Figure 3.12 Failure pattern of indirect tensile strength test.

For each series and each stage of elevated temperature, at least three specimens were tested and the mean value of these measurements is reported in this report.

3.6.4.3 Elastic Modulus Test

Elastic modulus test of SFRC, SFRGC(Na) and SFRGC(K) were performed in a 250 Ton UTM machine according to AS1012.17-1997 with a loading rate of 1.96 KN/sec to determine the stress to strain ratio of the concrete under axial load compression after exposure to different elevated temperatures and ambient temperature samples as well. The strain measuring gauges were placed symmetrically on either side of the cylinder about half way up the cylinders which is shown in Fig. 3.13 along with test setup of the elastic modulus. The test load of 40% of the ultimate compressive strength was applied at least three cycles of loading and off-loading on the specimen to test the modulus of elasticity. A computerised data logger was connected to the strain measuring gauges to collect the data and analysed to find out the elastic modulus of each specimens. Minimum three numbers of specimens for each stage of temperatures were tested and the average values were reported.

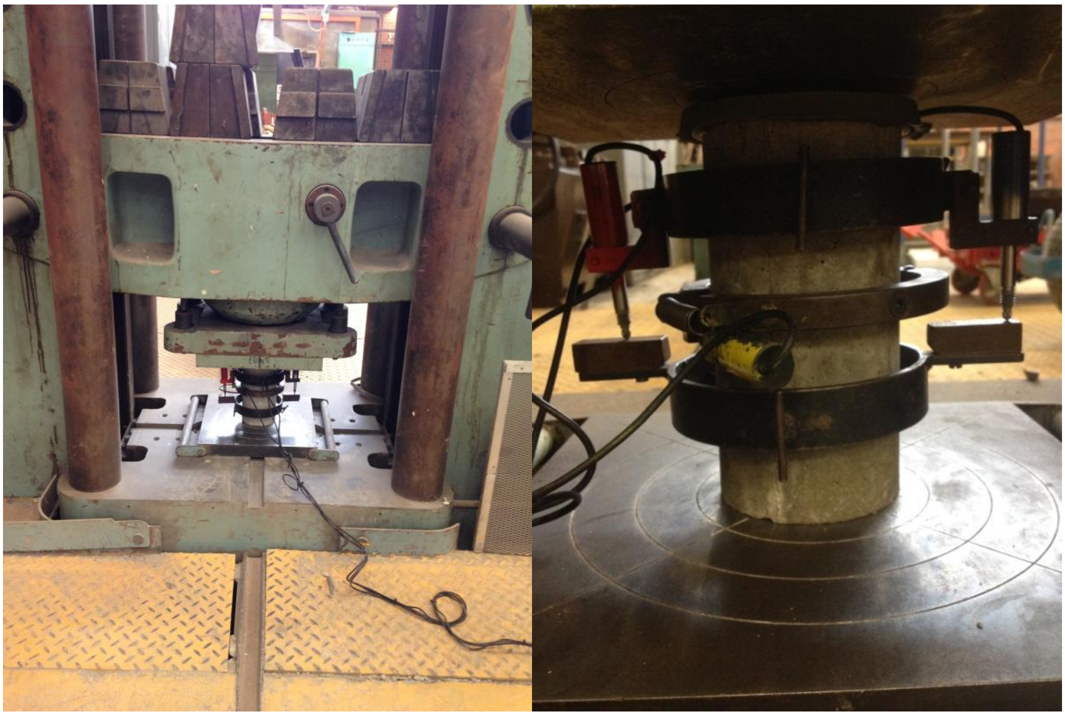


Figure 3.13 Test setup and gauges placement of Elastic Modulus test.

3.6.5 Cracking and Failure Behaviour of concrete cylinders

The cracking behaviour of concrete were evaluated by analysing the cracking pattern of the concrete surface of the concrete cylinders after exposure to elevated temperatures of 200^{o}C, 400^{o}C, 600^{o}C and 800^{o}C. The failure behaviour were also analysed by checking of damage and spalling pattern at ultimate compression load of all three types of concrete after exposure to elevated temperatures.

3.6.6 Steel Fibre Condition Test

To evaluate the steel fibre conditions in all three types of fibre reinforced concretes, steel fibres were collected from the samples after compressive strength test and checked the effect of elevated temperatures on the condition of surface pealing of the fibres.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the experimental program on geopolymer pastes, steel fibre reinforced concrete (SFRC) and steel fibre reinforced geopolymer concrete (SFRGC) of both alkali activators. The results are divided into two parts. First part evaluates the effects of sodium and potassium based activators on compressive strengths, volume and mass changes of fly ash geopolymer synthesized with both Na- and K-based activators exposed to elevated temperatures after 28 days of curing. The results on microstructural analysis of both geopolymer pastes are also discusses in this part. The effects of two types of alkali activators (Na- and K-based) on the residual mechanical properties of steel fibre reinforced geopolymer concrete (SFRGC) after exposed to various elevated temperatures are discussed and compared with those of conventional steel fibre reinforced concrete (SFRC) in the second part of this chapter. Compressive strength, indirect tensile strength and elastic modulus of above three types of steel fibre reinforced concretes are measured after exposure to elevated temperatures of 200°C, 400°C, 600°C and 800°C.

In addition, the cracking and failure behaviour of all SFRGC under ultimate compression is also compared with SFRC and steel fibres condition in all three types of concrete after exposure to elevated temperatures are also discussed in this part.

4.2 Part I:Behaviour of fly ash geopolymer pastes synthesized with Na and K-based activator after exposure to elevated temperatures

4.2.1 Workability of Geopolymer Pastes Containing Na- and K-based Activator

The workability of geopolymer pastes was observed during the mixing and casting process. With the alkali activator to fly ash ratio of 0.35 in all mixes, workability decreased gradually with the increase of silicate to hydroxide ratios from 2.0 to 2.5 and 2.5 to 3.0 of sodium based alkali activator.

On the other hand, the workability of geopolymer paste containing K-based activator was better than Na-based counterpart. However, similar to Na-based activator the increases in silicate to hydroxide ratio of K-based activator also slightly reduced the workability.

4.2.2 Residual Compressive Strengths

The measured compressive strengths of geopolymer pastes containing different Na_2SiO_3/NaOH ratios of 2, 2.5 and 3 after exposed to 200^{o}C, 400^{o}C, 600^{o}C and 800^{o}C temperatures are shown in Fig. 4.1. It can be seen that the residual compressive strengths of geopolymer paste containing Na_2SiO_3/NaOH ratio of 2 and 2.5 are increased by about 9% to 11% at 200^{o}C compared to ambient temperature strength. However, with further heating at 400^{o}C, 600^{o}C and 800^{o}C temperatures the residual compressive strengths of above geopolymer pastes are decreased below the ambient condition (see Fig. 4.2). On the other hand, the same geopolymer paste containing Na_2SiO_3/NaOH ratio of 3 showed significant increase in residual compressive strength by about 25% to 35% up to 600^{o}C with exception at 800^{o}C, where the residual compressive strength is decreased by more than 30% (See Fig. 4.2).

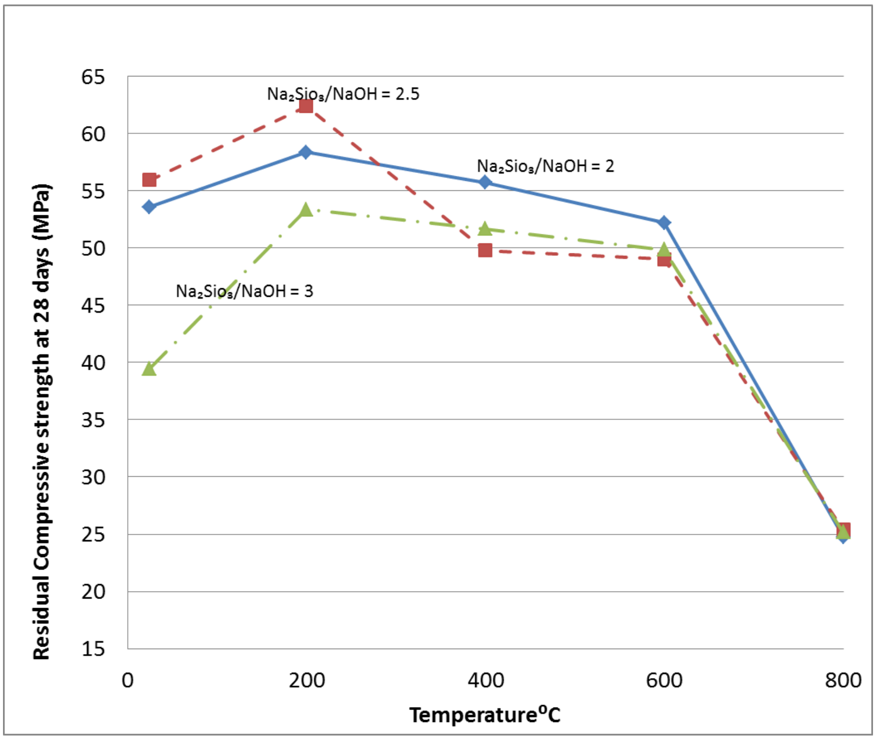


Figure 4.1 Residual compressive strengths of geopolymer pastes containing Na-based activators at various elevated temperatures.

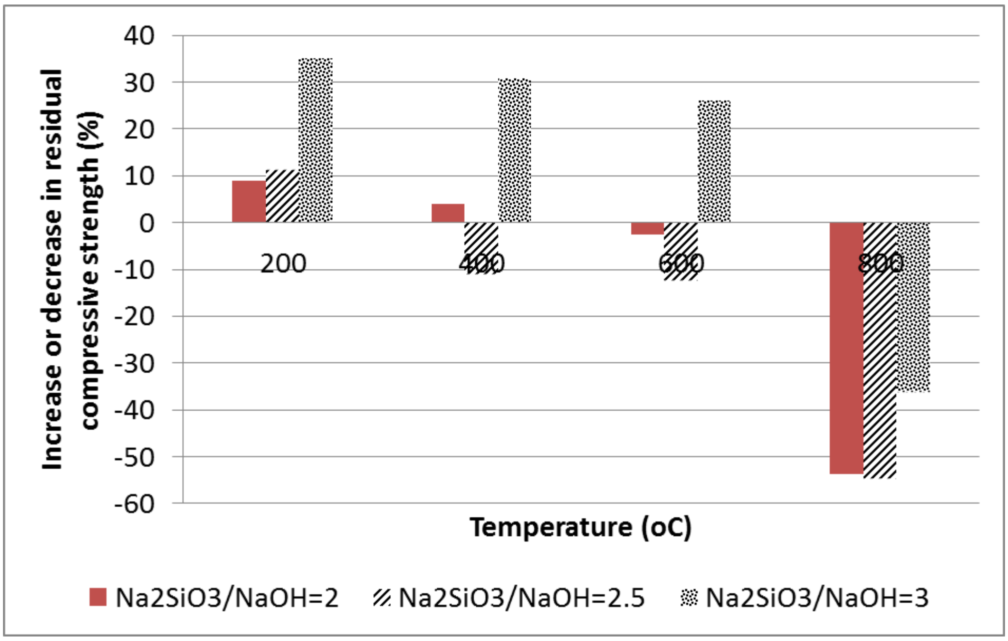


Figure 4.2 Relative increase or decrease in residual compressive strength of geopolymer pastes containing Na-based activators at various elevated temperatures compared to ambient temperature.

The effect of K-based activators on the compressive strength of geopolymer paste at elevated temperatures is also evaluated in this study and is shown in Fig. 4.3 and Fig. 4.4. Fig. 4.3 shows the measured compressive strengths of geopolymer pastes containing different K_2SiO_3/KOH ratios of 2, 2.5 and 3 after exposing to 200^{0}C, 400^{0}C, 600^{0}C and 800^{o}C temperatures. It can be seen in the figure that for all three K_2SiO_3/KOH ratios the residual compressive strengths of geopolymer pastes are much higher than the ambient temperature strength and the residual compressive strengths are increased with increase in elevated temperatures until 600^{o}C. It is also interesting to see that at 400^{0}C and 600^{o}C the geopolymer paste containing K_2SiO_3/KOH ratios of 2 and 2.5 show about 40% to 55% increase in compressive strength compared to ambient condition. Although the increase in compressive strength of paste containing K_2SiO_3/KOH ratios of 3 is slightly lower (about 22% to 26%) at those temperatures, the compressive strength is increased by about 5% at 800^{o}C temperature, which is not observed in the case of K_2SiO_3/KOH ratios of 2 and 2.5 (see Fig. 4.4).

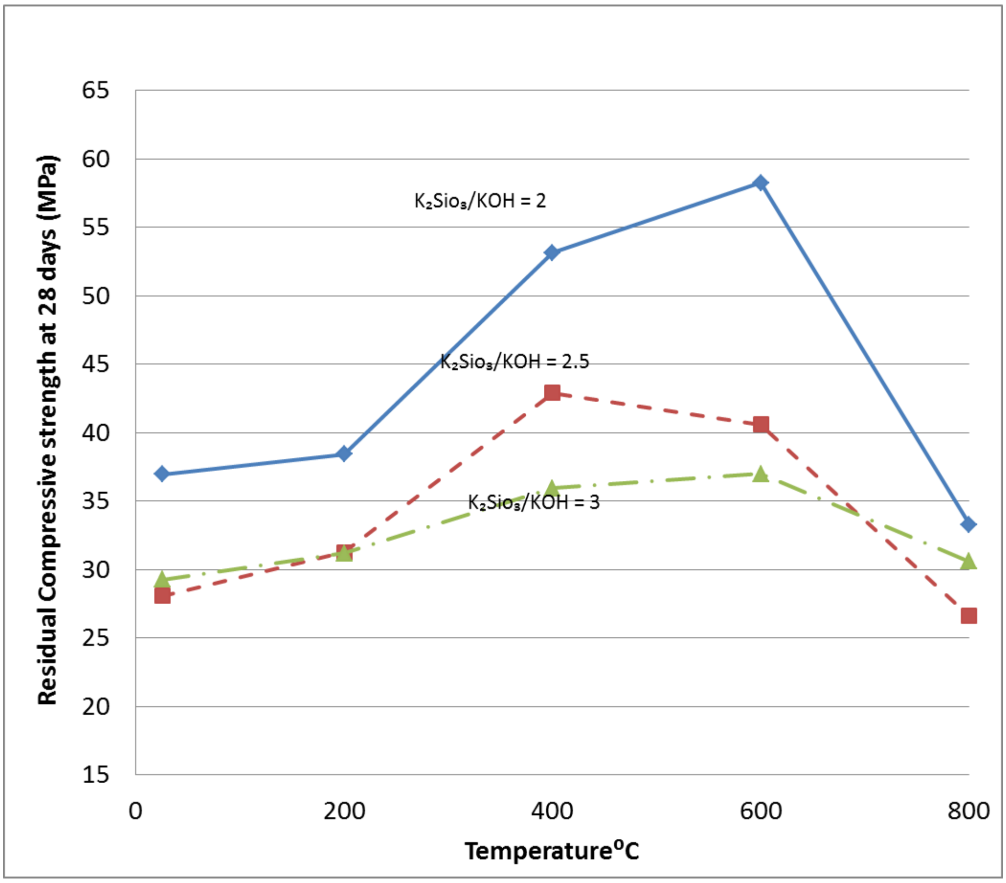


Figure 4.3 Residual compressive strength of geopolymer pastes containing K-based activators at various elevated temperatures.

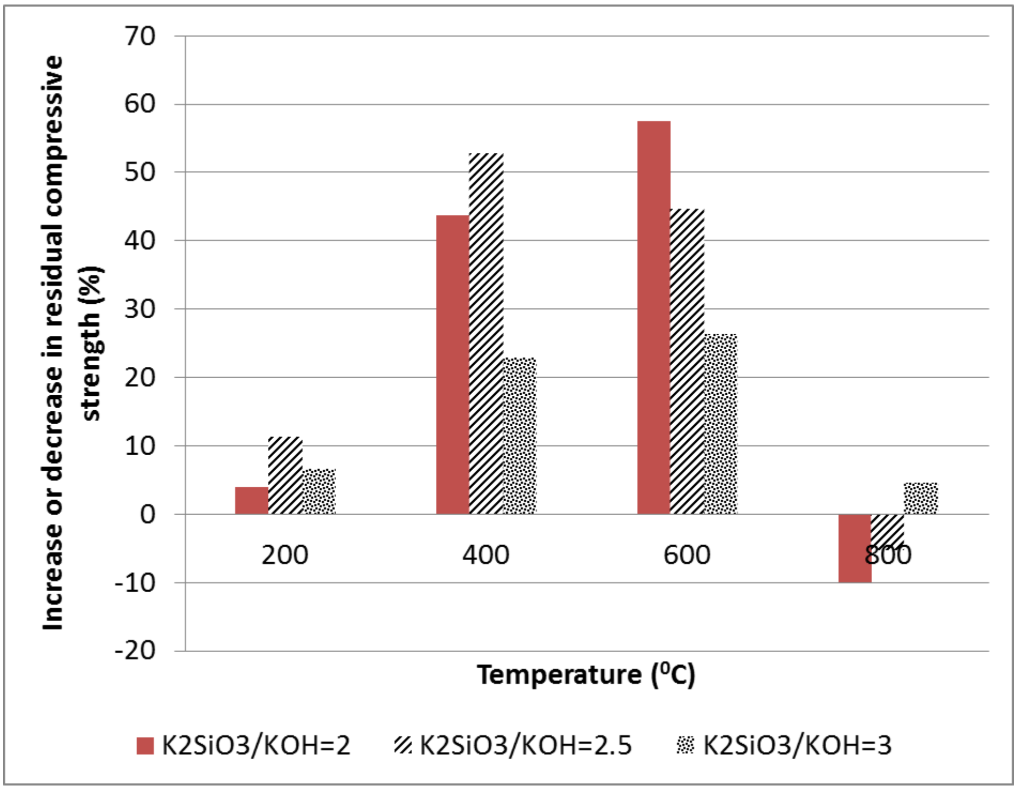


Figure 4.4 Relative increase or decrease in residual compressive strength of geopolymer pastes containing K-based activators at various elevated temperatures compared to ambient temperature.

By comparing both Na and K based geopolymer series in Figure 4.5 it can be clearly seen that the K-based activators show higher compressive strength retention capacity for geopolymer pastes than its counterpart Na-based series compared to ambient temperature strength. It can also be seen that in both geopolymers the ambient strength decreases with increase in silicate/hydroxide ratios for both Na- and K-based activators. This is attributed to the low water evaporation and less geopolymer structure formation due to excessive sodium silicate and potassium silicate (Chew, 1993). Interestingly the geopolymer with $K_2SiO_3/KOH=3$ exhibited higher compressive strength at all elevated temperatures than ambient temperature, which is also true for Na-based counterpart, however up to 600^{o}C. The increase in compressive strength in the former can be attributed to the lower diffusion coefficient of K^+ at elevated temperatures, which results in higher melting temperature (Bakharev, 2006).

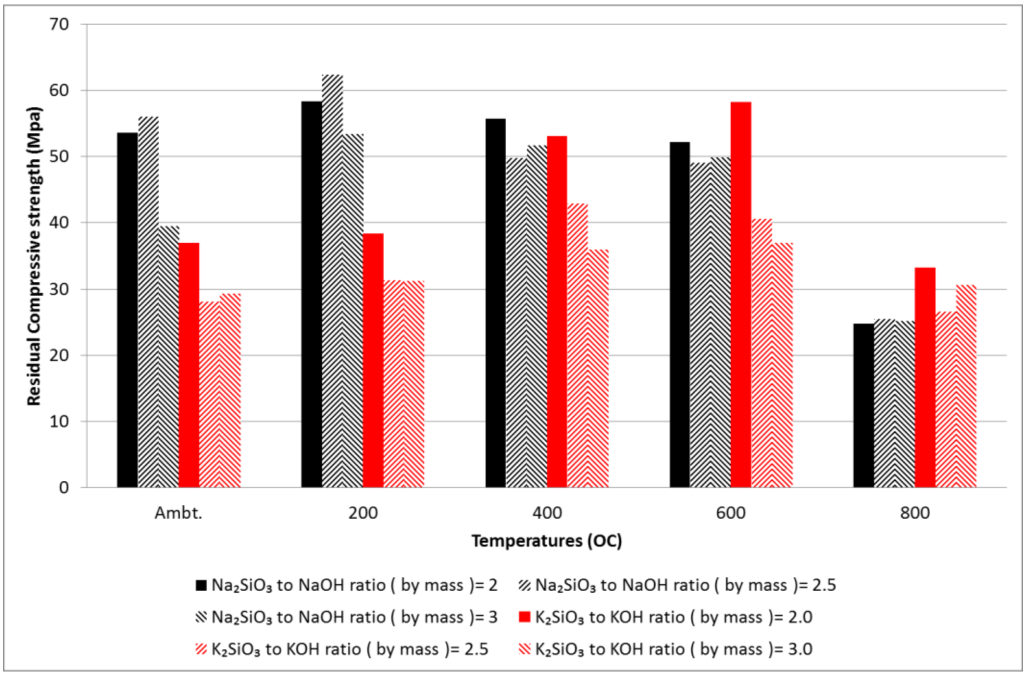


Figure 4.5 Comparison of compressive strengths of Na- and K-based geopolymer pastes.

4.2.3 Post-Heating Physical Behaviour

The effects of elevated temperatures on physical behaviour of both Na- and K-based activator synthetized fly ash geopolymers are shown in Figs 4.6, 4.7 and 4.8. Fig. 4.6 shows the formation of cracks on specimens' surface in both geopolymers. It can be seen that up to 400^{o}C no cracks are formed in both geopolymers. However, Na-based geopolymer showed signs of cracks at 600^{o}C and it becomes worst at 800^{o}C, where many wide cracks on the surface are formed. The geopolymer containing K-based activator, however, survived from surface cracking up to 600^{o}C, but fine cracks are formed at 800^{o}C.

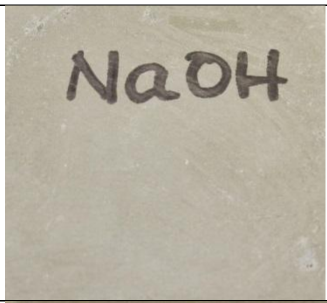
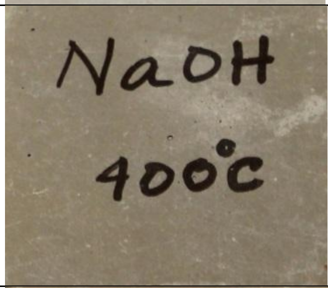
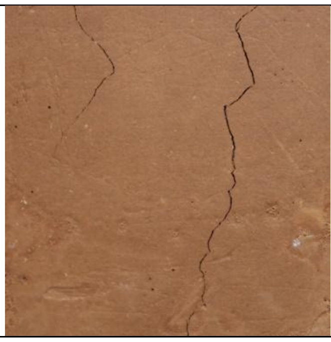
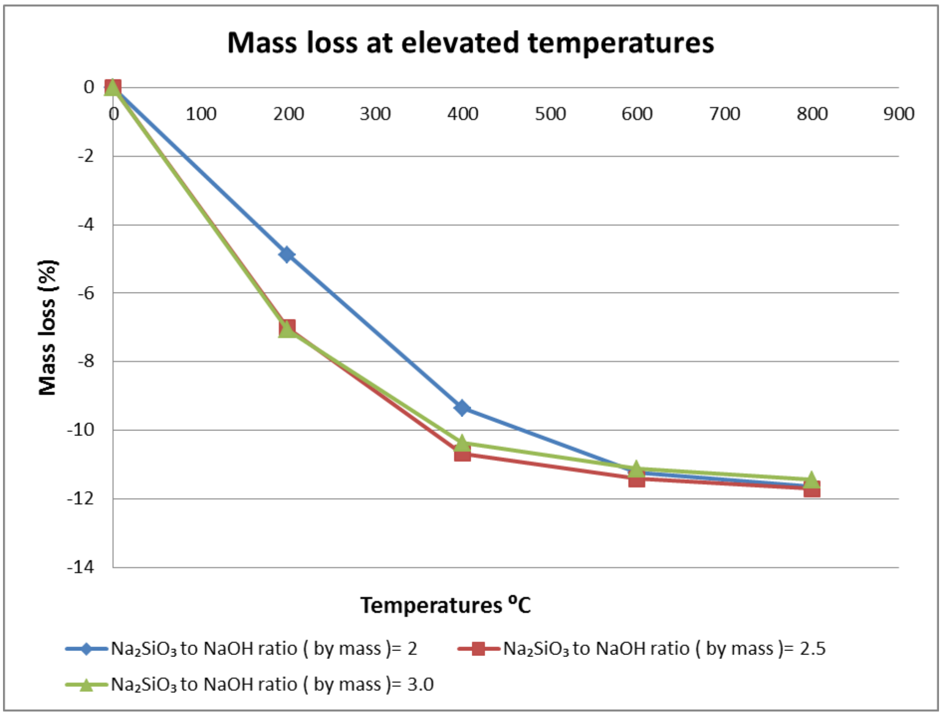
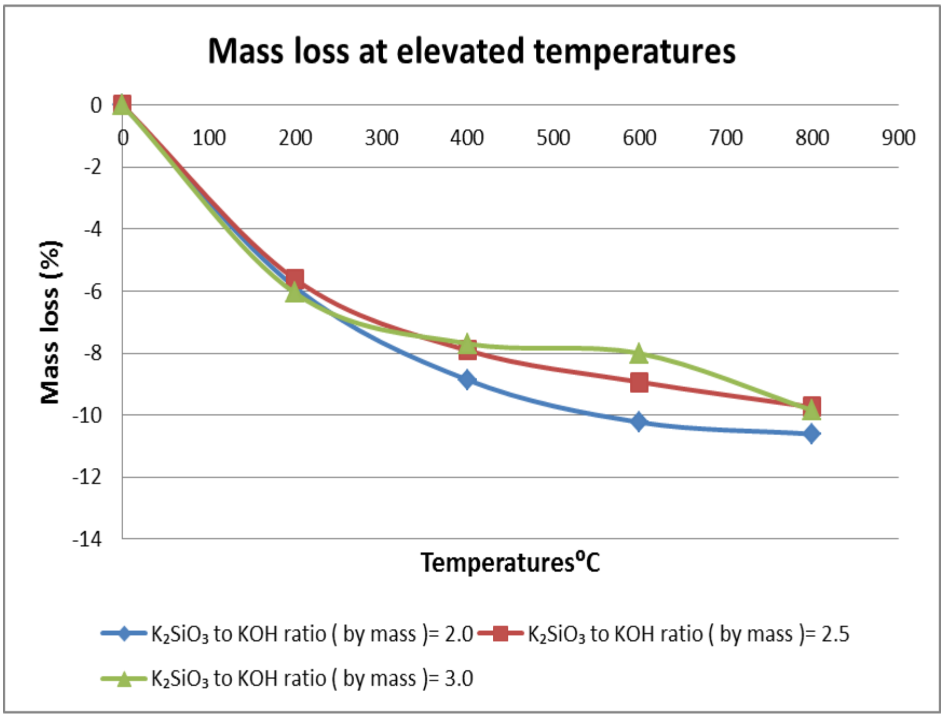
	Na-based	K-based
200°C		
400°C		
600°C		
800°C		

Figure 4.6 Cracking behaviour of fly ash geopolymers containing Na- and K-based activators at elevated temperatures.

Fig. 4.7 shows the reduction of mass of both geopolymers at various elevated temperatures. It can be seen that the mass loss of Na-based geopolymer is slightly higher than that of K-based counterpart. An interesting observation is also noted that by increasing the Na_2SiO_3/NaOH ratios the mass loss is slightly increased, which is opposite in the K-based system. It can also be seen that up to 400°C significant reduction in mass loss of about 8% to 10% is observed in both geopolymers and the mass loss becomes stable afterword.



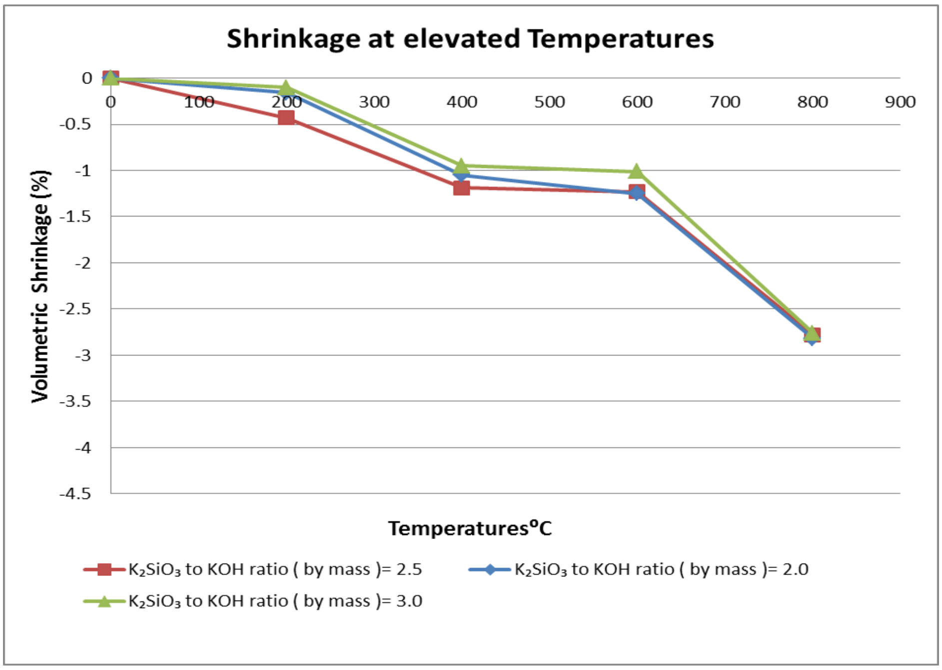
(a)



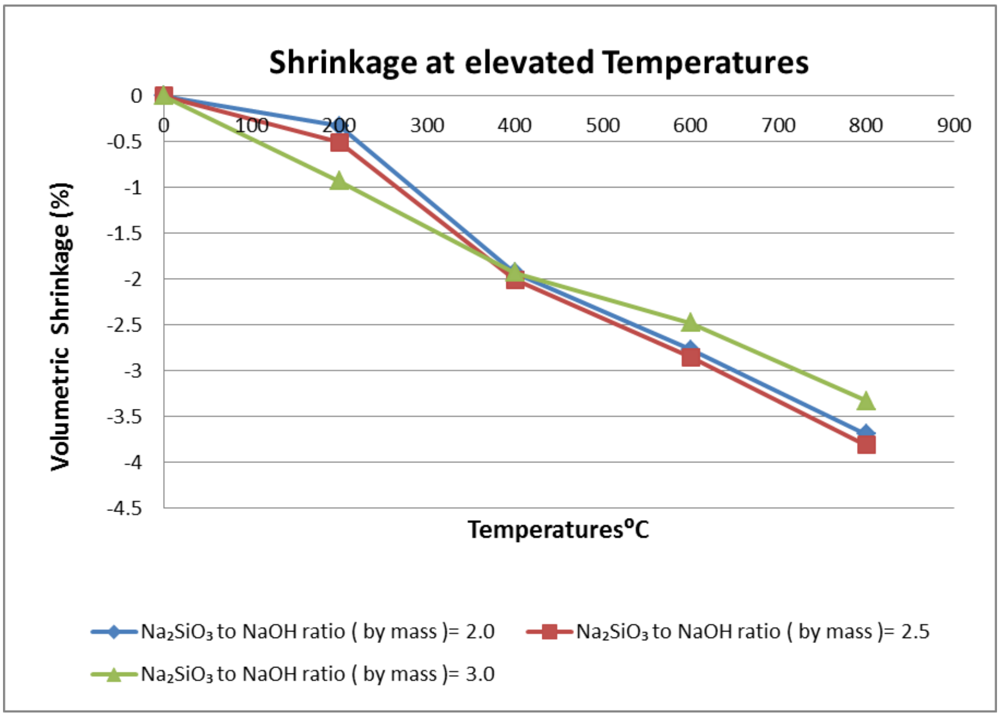
(b)

Figure 4.7 Comparison of mass loss of Na- and K-based geopolymer pastes at elevated temperatures.

In the case of volumetric shrinkage (Fig. 4.8) of both geopolymers at elevated temperatures similar results to those of mass loss are also observed, where the K-based geopolymer showed lower shrinkage than its Na-based counterpart at all elevated temperatures. The observed less cracks in the K-based activator synthetized geopolymer is due to its lower mass loss and lower volumetric shrinkage than Na-based system. The higher residual compressive strength of K-based activator synthetized geopolymer than its counterpart Na-based system is also due the less cracking in the former than the latter, as pre-existing cracks cause stress concentration in the specimen under compression and hence failure at lower loads.



(a)



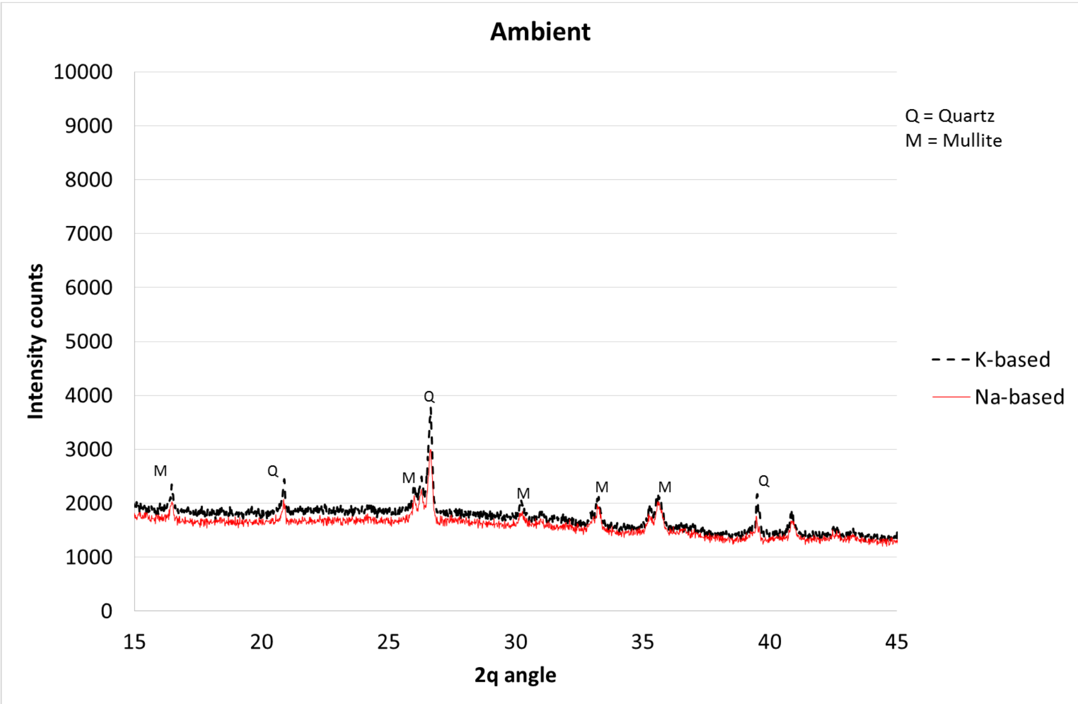
(b)

Figure 4.8 Comparison of volumetric shrinkage of Na- and K-based geopolymer pastes at elevated temperatures.

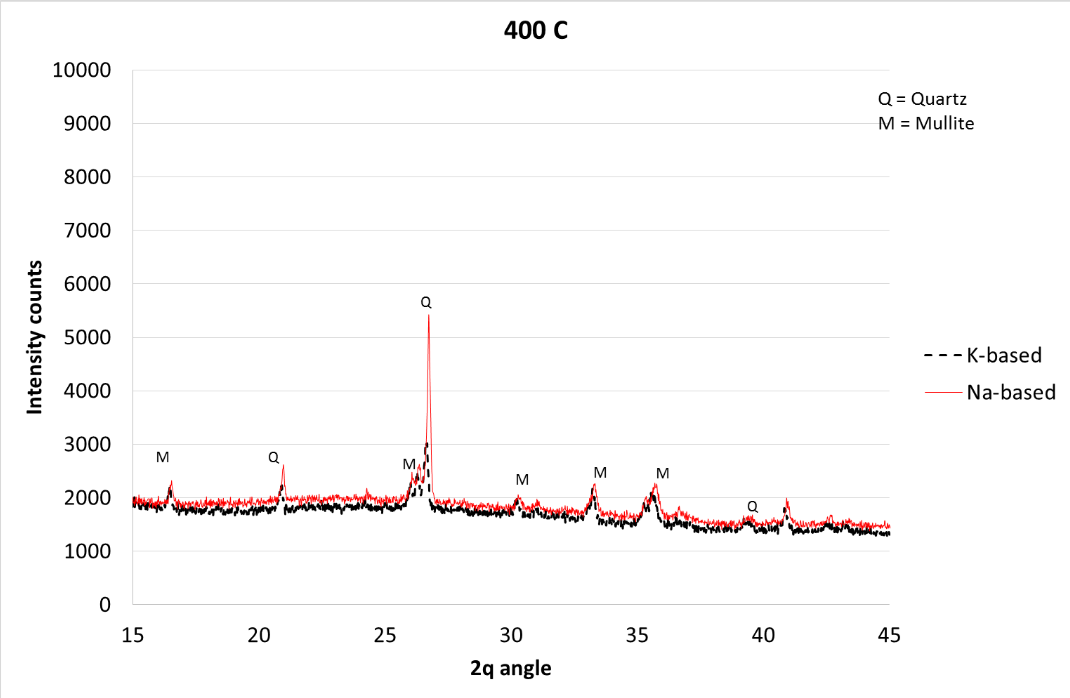
4.2.4 Microstructural Analysis Considering Phase and Thermal Results

Among three different ratios of silicate-to-hydroxide of both Na- and K-based activators the ratio 3 exhibited the best in terms of highest residual compressive strengths after elevated temperatures exposure. Even among Na and K-based activators the K-based activator showed the best performance. In order to get more insight on the above difference in behaviour powder samples were collected from tested specimens at ambient condition, 400^{o}C and 800^{o}C for both activators for silicate-to-hydroxide ratio of 3. X-ray diffraction (XRD), thermogravimetric analysis (TGA) and differential thermal analysis (DTA) of above powder samples were conducted to identify the change in geopolymer reaction phases due to exposure to elevated temperatures for both activators. Figs. 4.9a-c show the XRD patterns of both Na and K-based geopolymers at ambient and after exposure to 400^{o}C and 800^{o}C temperatures. The strong peaks in the fly ash geopolymers mainly identify the presence of quartz and mullite at ambient temperature. Mullite is the stable crystalline phase of the Al_2O_3-SiO_2 system under atmospheric condition and is a refractory. Mullite retains its room temperature strength at elevated temperatures and has high temperature stability up to 1840^oC (Rickard et al., 2012) with low thermal expansion and oxidation resistance. In Both Na- and K-based fly ash geopolymers at room temperature several quartz peaks at 2θ angles of 20.83^o, 26.65^o and 39.51^o and several mullite peaks at 2θ angles of 16.46^o, 26.53^o, 30.26^o, 33.20^o and 35.66^o are observed (Fig. 4.9a). However, in K-based geopolymer the quartz and mullite peaks are more prevalent than the Na-based system. Both geopolymers after exposure to 400^oC also show the presence of quartz and mullite peaks, with slightly stronger quartz and mullite peaks in Na-based geopolymer than the K-based geopolymer. After 800^oC an opposite trend is observed with stronger quartz and mullite peaks in K-based geopolymer than the Na-based geopolymer.

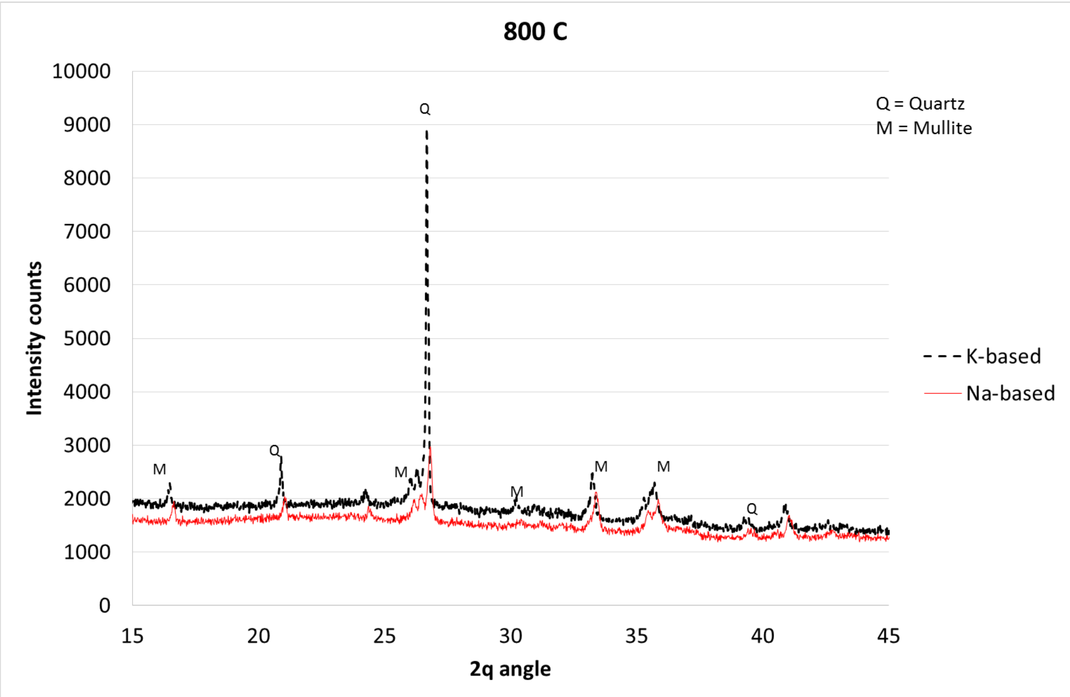
Thermogravimetric analysis (TGA) and differential thermal analysis (DTA) were used to assess the weight loss during controlled heating of both Na- and K-based fly ash geopolymers before and after exposure to elevated temperatures in order to identify the present of phases. Figs. 4.10a-c show the TGA and DTA curves of both geopolymers at ambient condition and after heating to 400^0C and 800^oC temperatures. It can be seen in Fig. 4.10a that the weight loss of Na-based fly ash geopolymer is much higher than its K-based counterpart. In DTA curves a peak is located at approximately 90^oC and is caused by loss of absorbed and combined water in the N-A-S-H gels (Rashad and Zeedan, 2011). It can also be seen that the DTA peak is greater for Na-based fly ash geopolymer than its K-based counterpart, meaning more geopolymerization has occurred with Na-based activator (Rashad and Zeedan, 2011). And this can be reflected by comparing the compressive strength values in Figs. 4.1 and 4.3 at ambient temperature for both geopolymers. On the other hand, the weight loss in both geopolymer in TGA decreased after their exposure to 400^oC and 800^oC and the difference in weight loss between the Na- and K-based systems decreased gradually at 400^oC and 800^oC exposures. This is also reflected in the reduction in the difference in peaks in DTA curves in both geopolymers at both 400^0C and 800^oC temperatures. This lower weight loss in both geopolymers can be attributed to the loss of absorbed water in the geopolymer matrix due to heating at 400^oC and the combined water in geopolymer gels at 800^oC. No weight loss or DTA peak at approximately 450^oC is observed which is usually for $Ca(OH)_2$. It is also interesting to note that the weight loss and the DTA peak at approximately 100°C is higher in Na-based geopolymer than its K-based counterpart at 400°C exposure. On the other hand, the K-based geopolymer showed slightly higher weight loss and DTA peak than Na-based geopolymer at 800°C. These results are consistence with XRD and compressive strength results, where the XRD peaks of quartz and mullite phases are higher in Na-based fly ash geopolymer than the K-based at 400°C compared to 800°C. The residual compressive strength of Na-based fly ash geopolymer is also higher than the K-based geopolymer at 400°C.



(a)

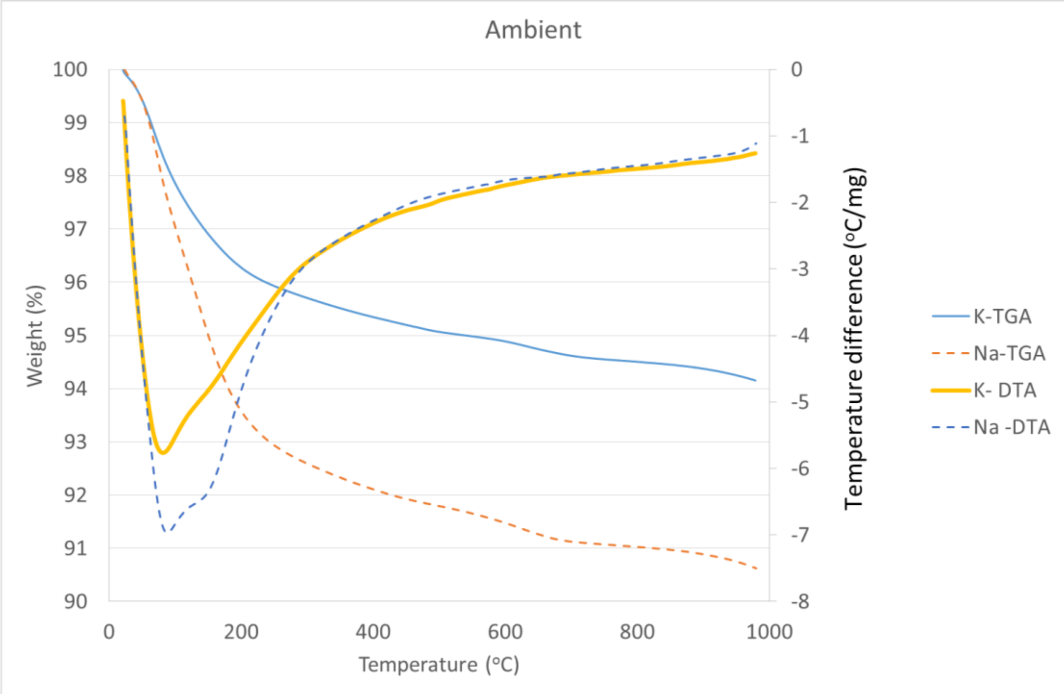


(b)

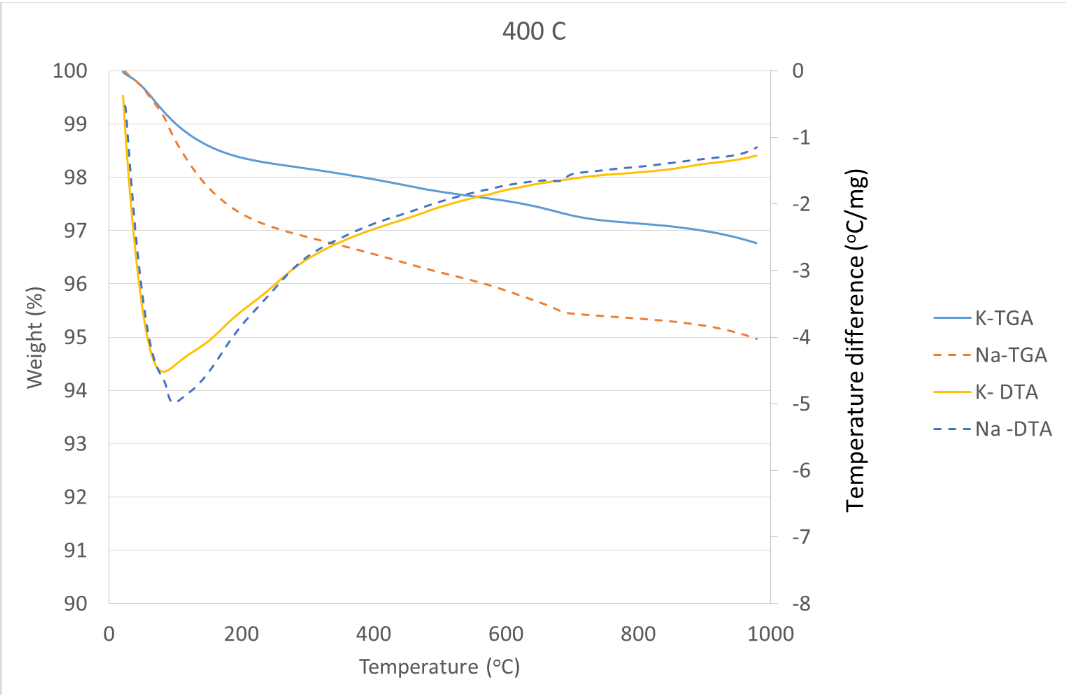


(c)

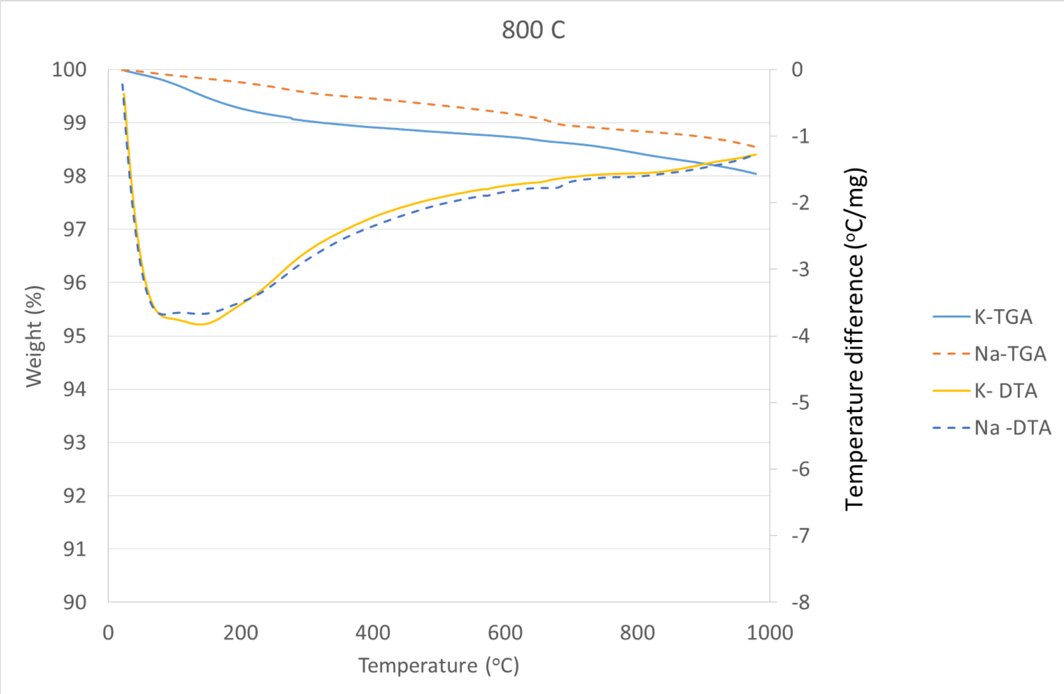
Figure 4.9 XRD analysis results of Na- and K-based fly ash geopolymer at (a) ambient, (b) at 400°C and (c) at 800°C temperatures.


Ambient
100
99
98
97
96
95
94
93
92
91
90
Weight (%)
0
-1
-2
-3
-4
-5
-6
-7
-8
Temperature difference (°C/mg)
0
200
400
600
800
1000
Temperature (°C)
K-TGA
Na-TGA
K- DTA
Na -DTA

(a)


400 C
100
99
98
97
96
95
94
93
92
91
90
Weight (%)
0
-1
-2
-3
-4
-5
-6
-7
-8
Temperature difference (°C/mg)
0
200
400
600
800
1000
Temperature (°C)
K-TGA
Na-TGA
K- DTA
Na -DTA

(b)



(c)

Figure 4.10 TGA/DTA analysis results of Na- and K-based fly ash geopolymer at (a) ambient, (b) at 400°C and (c) at 800°C temperatures.

After all the test and analysis of geopolymer pastes specimens, it is clear that geopolymer paste with silicate to hydroxide ratio of 3 in both alkali activator exhibited best performance than the other ratios used in this study.

4.3Part II: Behaviour of SFRC and SFRGC containing Na and K-based activator after exposure to elevated temperatures.

4.3.1 Workability of SFRC and SFRGC containing Na and K-based activator

The workability of three series of steel fibre reinforced concrete mixes are shown in the Fig. 4.1 which were measured according to ASTM standard. This test was carried out by pouring mixed concrete into the slump cone in three layers and each layers was temped 25 times with the round end of the tamping rod. The excess concrete was strike off from the top surface of the cone to make it plain surface with the tamping rod and the cone was lifted vertically and the slump was measured by scale. At water (alkali activator)/ binder ratio of 0.4, SFRC and SFRGC(K) mixes exhibited better workability than SFRGC(Na). A naphthalene sulphonate superplasticizer was used to maintain the workability of the mixes of SFRGC(Na). The SFRC mixes has shown a higher slump than expected might be the reason of slight more water content of SSD aggregates. On the other hand, SFRGC(K) has shown better workability than its counterpart SFRGC(Na) as we have used K_2SiO_3 with lower specific gravity of 1.32 than Na_2SiO_3 solution with a specific gravity of 1.51 which largely affects the viscosity of both solution. A slight more water (alkali activator)/binder ratio used in the concrete mixes than that of paste mixes because of addition of aggregate and fibre to maintain the perfect workability according to ASTM standards.

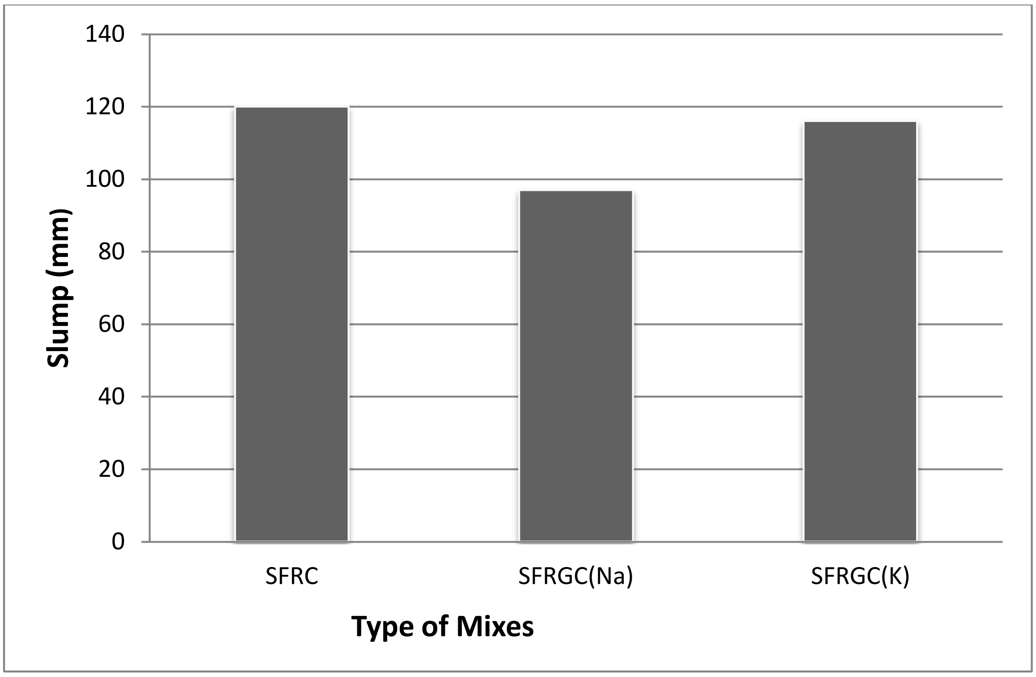
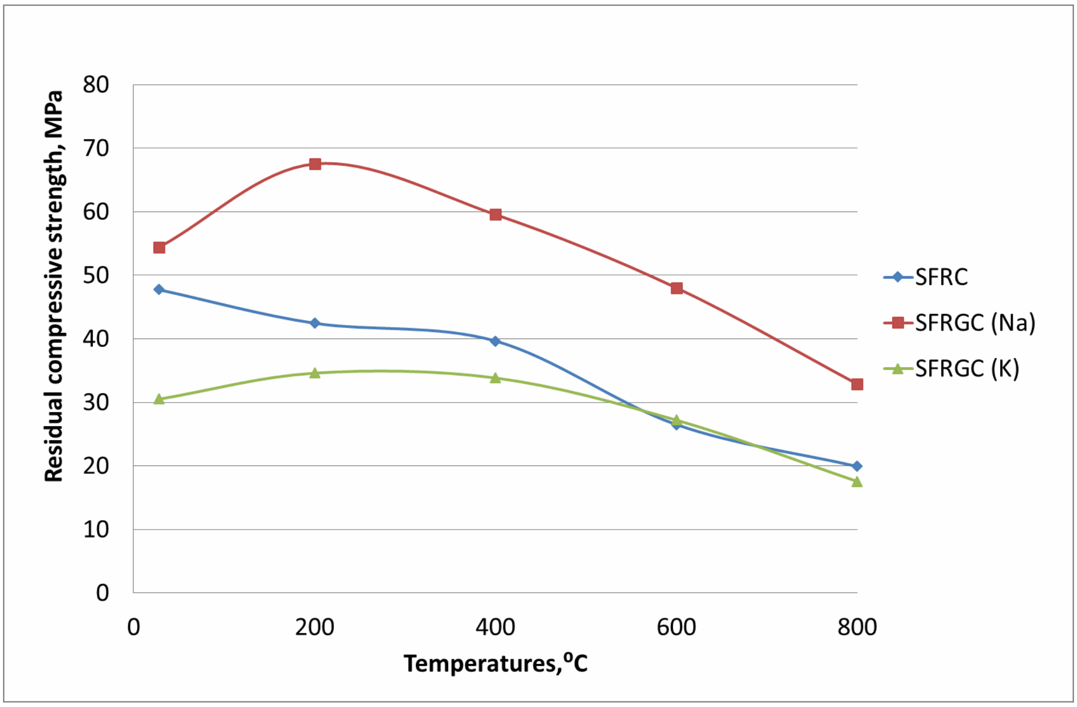


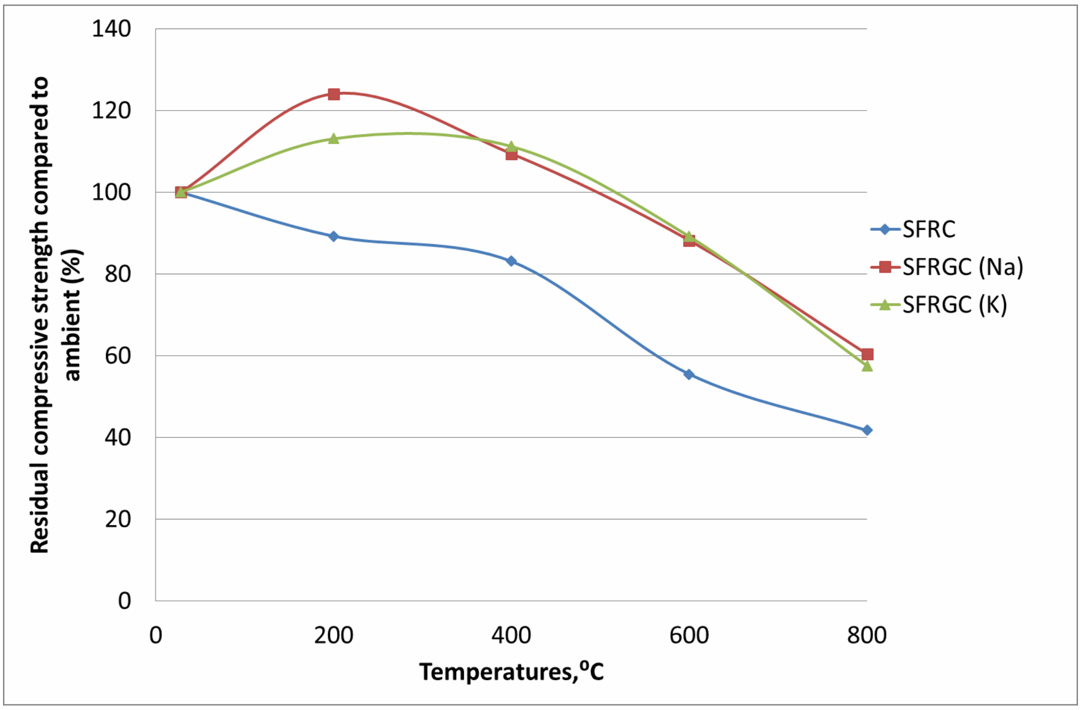
Figure 4.11 Workability of Concrete mixes.

4.3.2 Residual Compressive Strength

The effect of elevated temperatures on residual compressive strength of SFRGCs containing Na- and K-based activators is shown in Fig.4.12. A comparison is also made with SFRC in the same figure. It can be seen that the compressive strength of SFRGC(Na) at ambient temperature is much higher (about80%) than its K-based counterpart. The compressive strength of SFRC at ambient temperature is also higher (about50%) than the SFRGC(K). With increase in elevated temperature the compressive strength of SFRGC(Na) also increases until 400°C, where about 22% and 15% increase in compressive strength is observed at 200°C and 400°C, respectively. A similar behavior is also observed in SFRGC(K) with slightly lower increment of about 16% at 200°C. With further increase in temperature at 600°C and 800°C the compressive strength of both concretes decreased by about 10% and 40%, respectively. It is interesting to note that the behavior of SFRC at 200°C and 400°C temperature is different from its geopolymer counterpart, where about 10% and 18% reduction in compressive strength, respectively. The reduction at 600°C and 800°C is even higher by about 45% and 60%, respectively, about similar reduction is also reported by Chen and Liu, (2004).



(a)

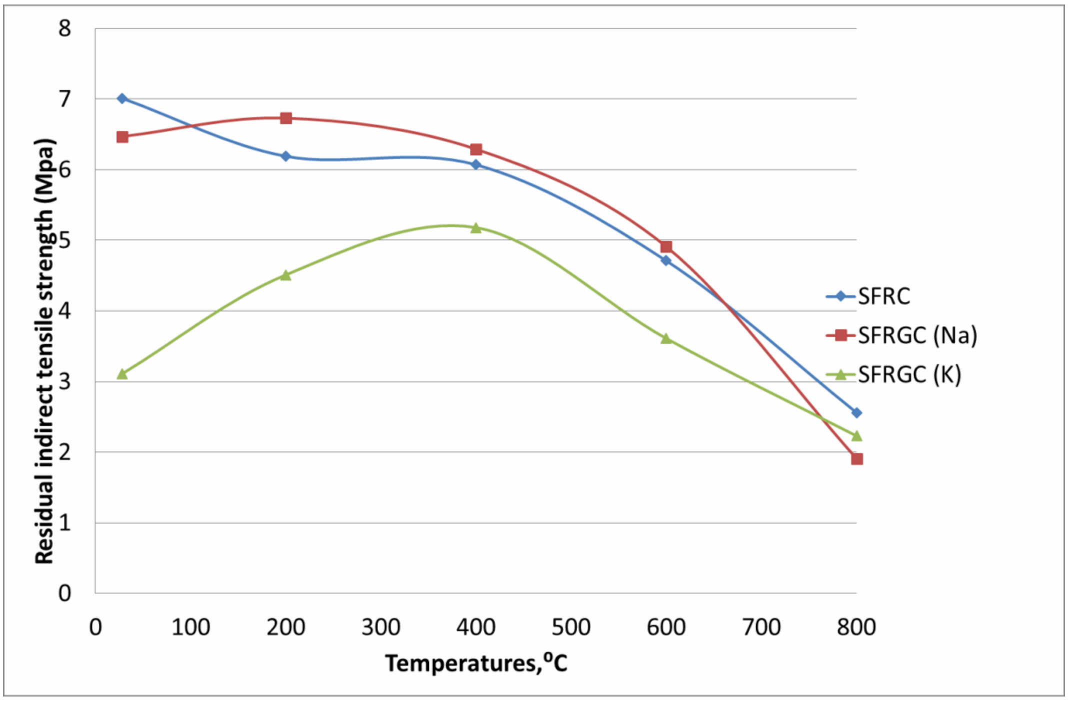


(b)

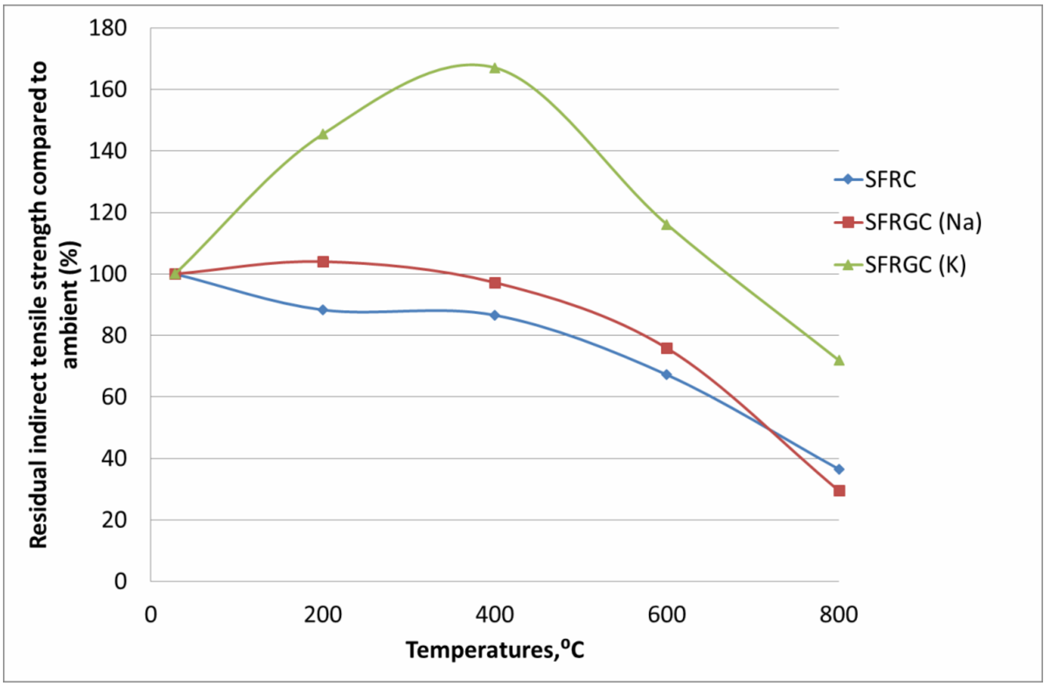
Fig. 4.12 Compressive strength of SFRC and SFRGC (Na) and SFRGC (K) at various elevated temperatures.

4.3.3 Residual Indirect Tensile Strength

The effect of elevated temperature on residual indirect tensile strength of above three concretes is shown in Fig. 4.13. Similar to that of compressive strength, the tensile strength of SFRGC(K) was also much lower than its Na-based counterpart and SFRC at ambient temperature. The SFRC and SFRGC(Na) show similar behavior where the indirect tensile strength decreases with increase in elevated temperatures. The reduction in indirect tensile strengths of SFRC is slightly more than those of SFRGC(Na) . However, the SFRGC(K) exhibited exceptionally better behavior up to 600^{o}C where the residual tensile strengths were higher than the ambient tensile strength. The residual tensile strength of SFRGC(K) increased as high as 65% at 400^{o}C compared to original at ambient condition. The loss of original tensile strength of SFRGC(K) is about half of SFRC and SFRGC(Na) at 800^{o}C. The superior behavior of SFRGC(K) than its Na-based counterpart is due to the measured smaller shrinkage in the dilatometry test shown in Fig. 4.14. Fig. 4.14 shows the percentage expansion or contraction of both geopolymers pastes due to heating up to 1000°C. It can be seen in Fig.4.14 that up to about 500°C the contraction of K-based geopolymer was very small compared to its Na-based counterpart. On the other hand the Granite coarse aggregate used in the concrete expands at elevated temperatures as can be seen in Fig.4.15 (Kong and Sanjayan, 2008), however, up to about 500°C the expansion is very low (about 1%). On the other hand, the contraction of Na-based geopolymer up to 500°C is about 2% and this difference caused more micro cracking in the interface between the coarse aggregates and the Na-based geopolymer matrix in the SFRGC(Na) than its counterpart SFRGC(K). The less micro cracks in aggregate/matrix interface in SFRGC(K) than SFRGC(Na) is believed to be the cause for higher tensile strength in SFRGC(K) up to about 500°C. After about 500°C the contraction of Na-based geopolymer increased more up to about 3% and the higher loss in tensile strength in the SFRGC(Na) at 600°C and 800°C could be due to more damage of aggregate/matrix interface. On the other hand, relatively smaller loss in tensile strength of SFRGC(K) compared to its Na-based counterpart could bee xpansion of K-based geopolymer after about 500°C as measured in this study.



(a)



(b)

Figure 4.13 Indirect tensile strength of SFRC and SFRGC(Na) and SFRGC (K) at various elevated temperatures.

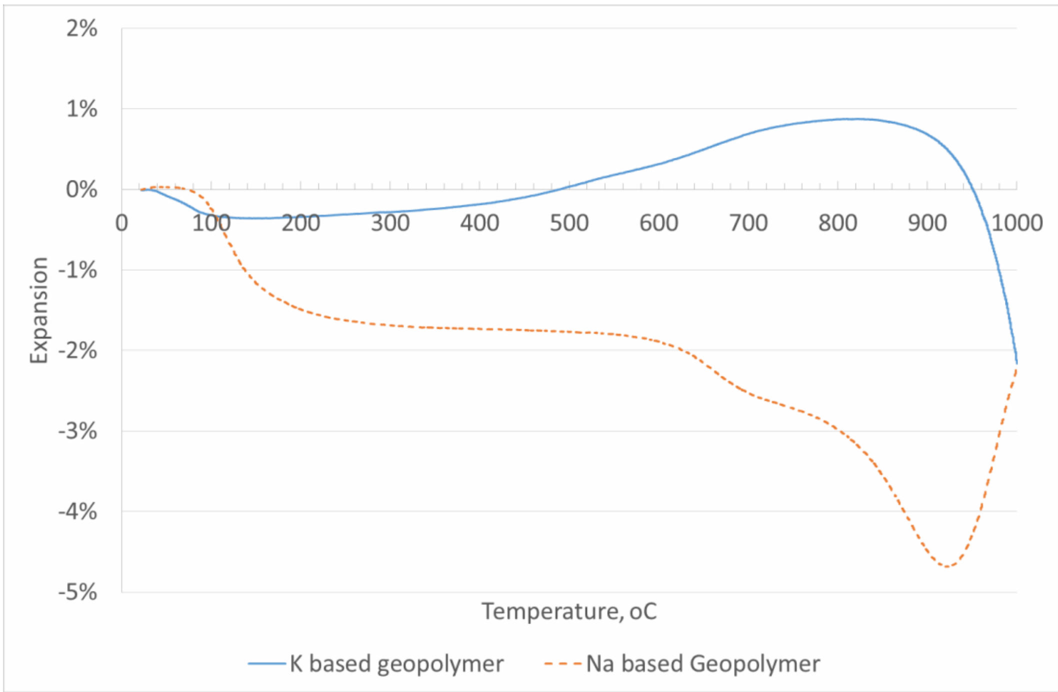


Figure 4.14 Linear expansion and contraction of Na- and K-based geopolymer at various elevated temperatures in Dilatometer test.

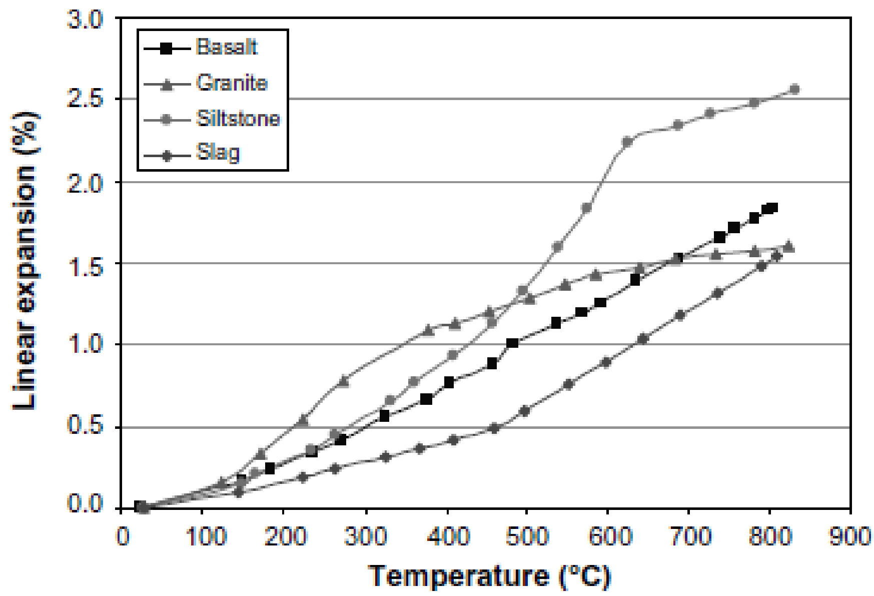
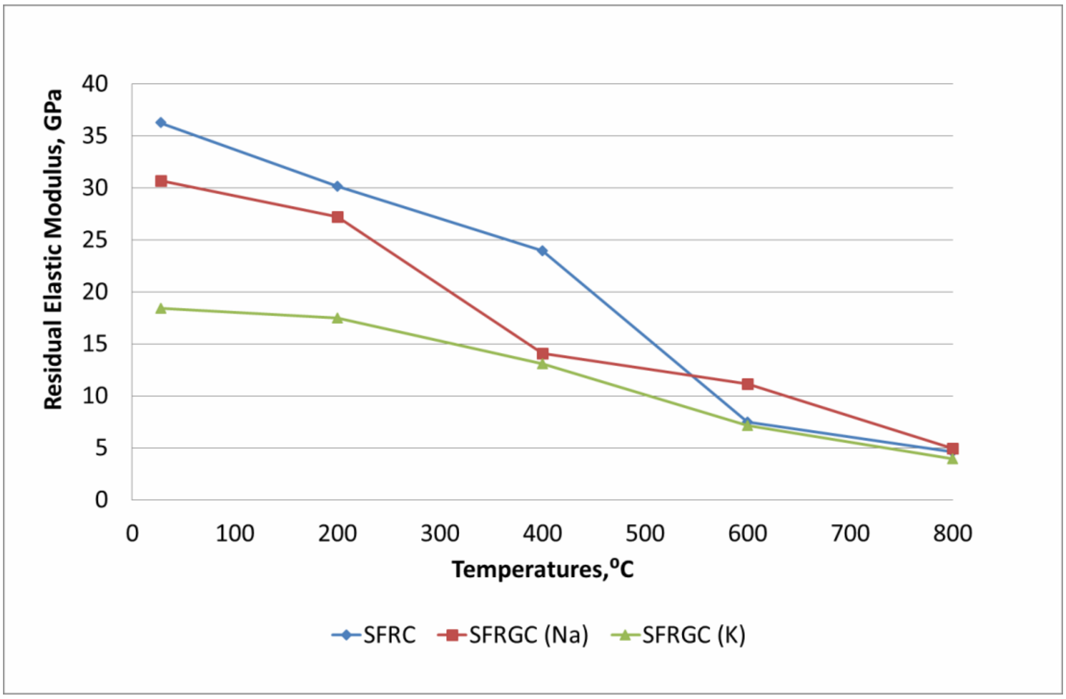


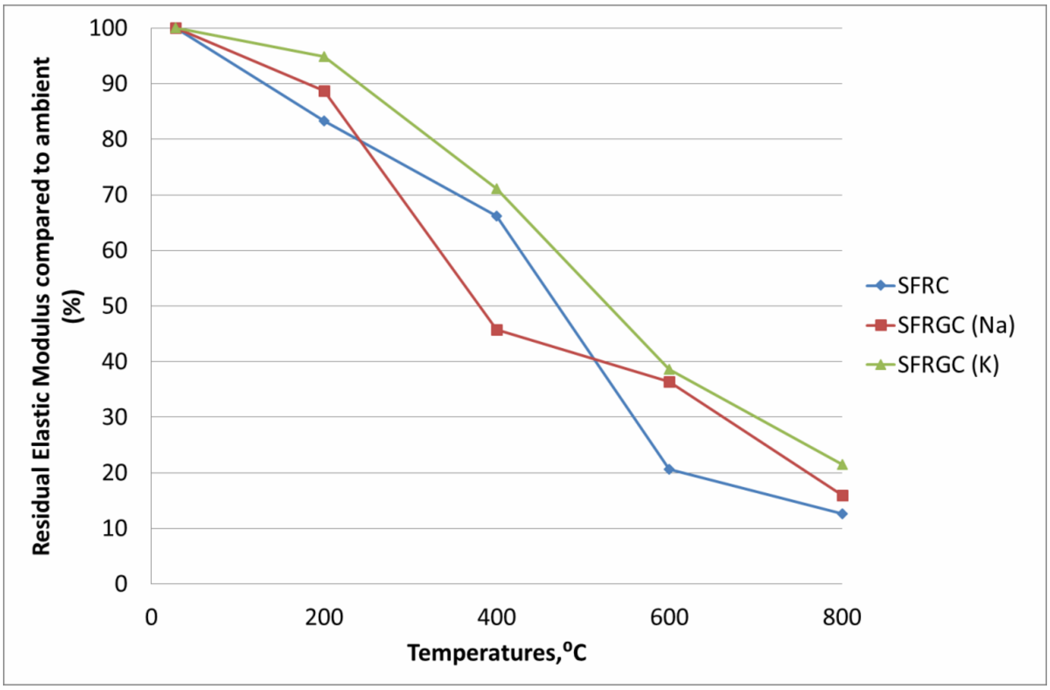
Figure 4.15 Linear expansion of various aggregates at various elevated temperatures in Dilatometer test. (Kong and Sanjayan, 2008)

4.3.4 Residual Elastic Modulus

The effects of elevated temperatures on the elastic modulus of all three types of steel fibre reinforced concretes are shown in Fig.4.16. It can be seen that similar to the compressive and tensile strengths, the elastic modulus of SFRGC(K) is also lower than its Na-based counterpart and SFRC at ambient temperature. Surprisingly, the elastic modulus of SFRGC(Na) is slightly lower than SFRC. Upon heating at various elevated temperatures all three concretes showed gradual reduction in elastic modulus. The correlations between the tensile strength and the compressive strength and between the elastic modulus and the compressive strength of all three concretes are also established in this study and are shown in Figs.4.17 and4.18, respectively. It can be seen that the SFRC shows strong correlation with R^2>0.9 in both cases. Very good correlations are also observed between the tensile strength and the compressive strength in both SFRGCs. However, in the case of elastic modulus no strong correlation with the compressive strength of SFRGCs is observed.



(a)



(b)

Figure 4.16 Elastic modulus of SFRC and SFRGC(Na) and SFRGC(K) at various elevated temperatures.

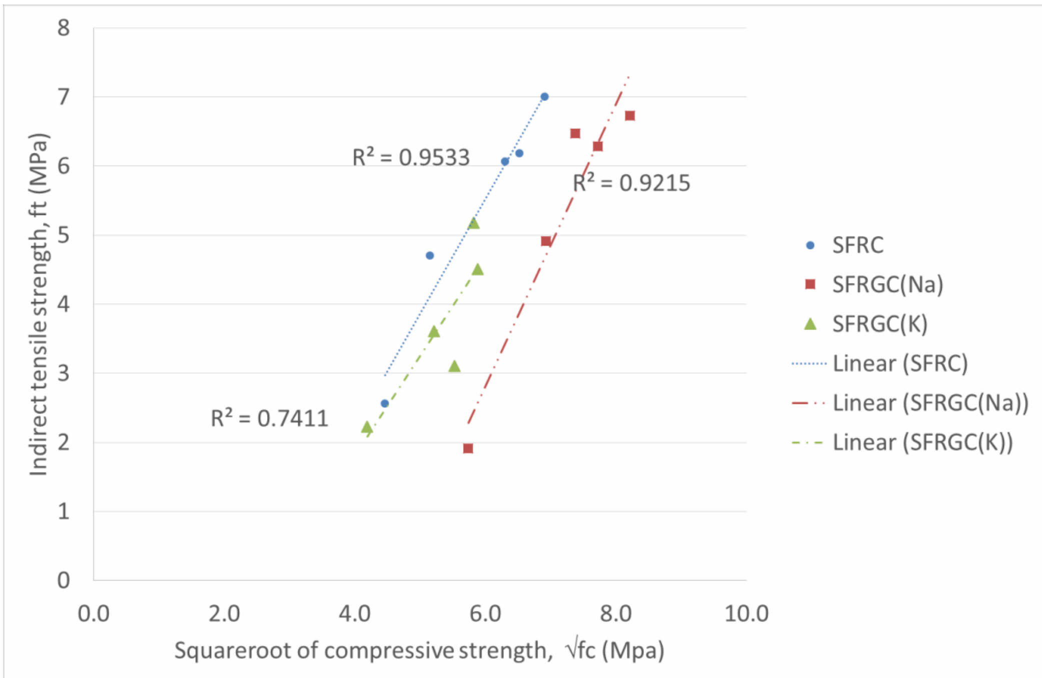


Figure 4.17 Correlation of indirect tensile strength with compressive strength of SFRC, SFRGC(Na) and SFRGC(K).

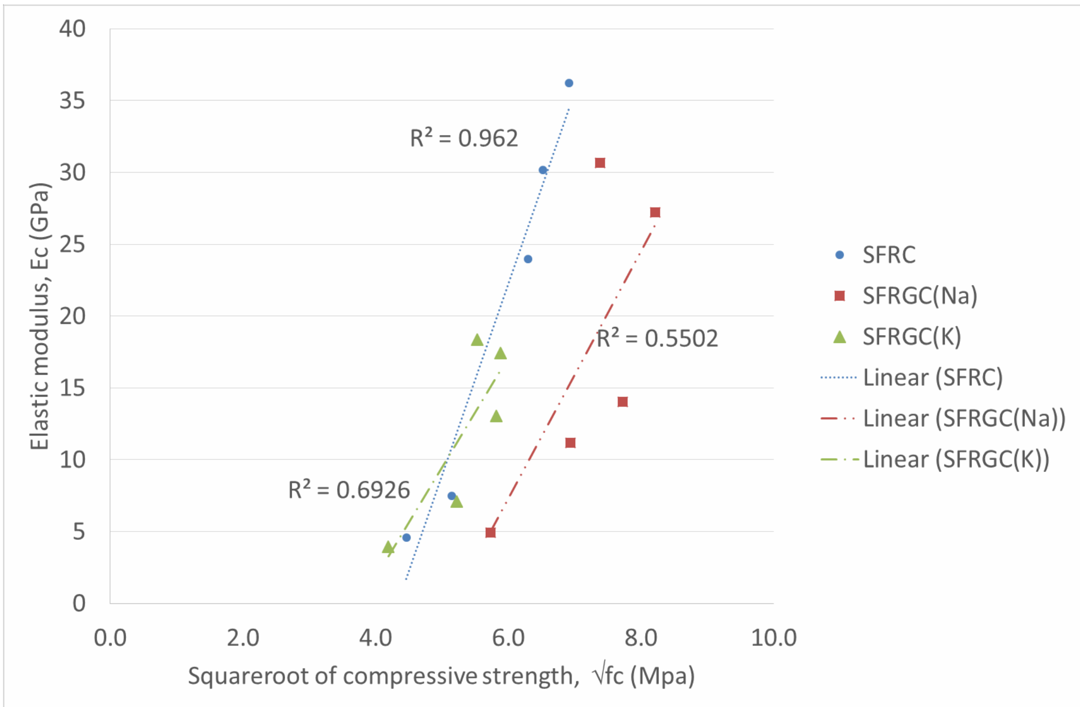
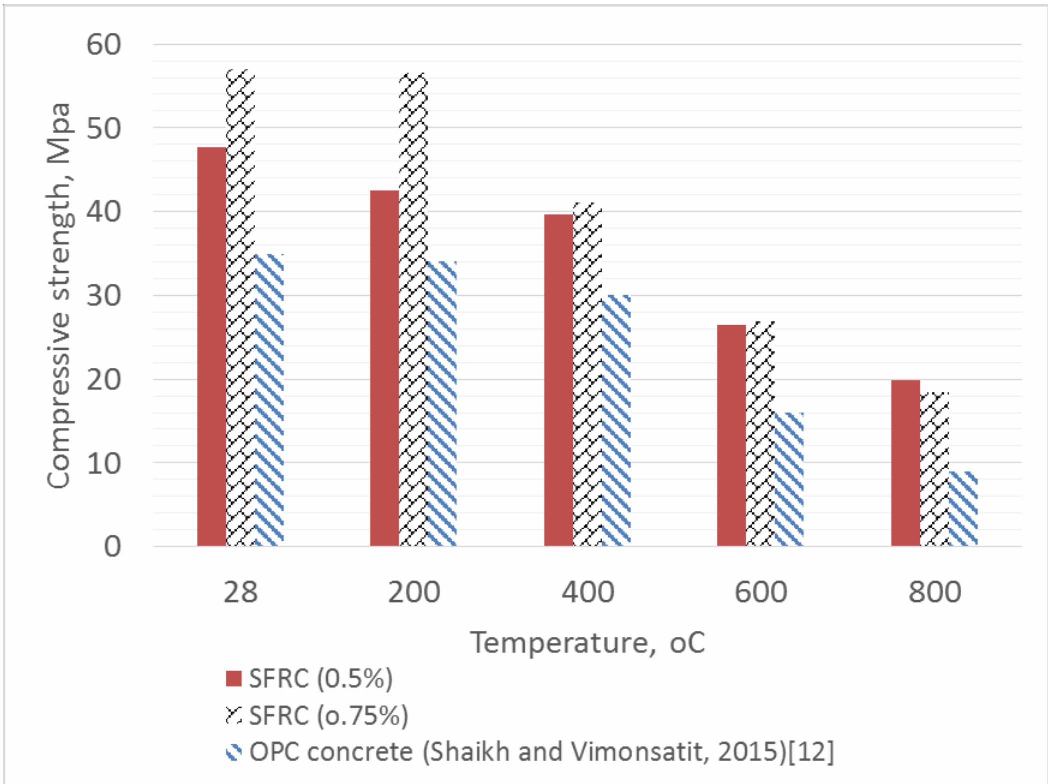


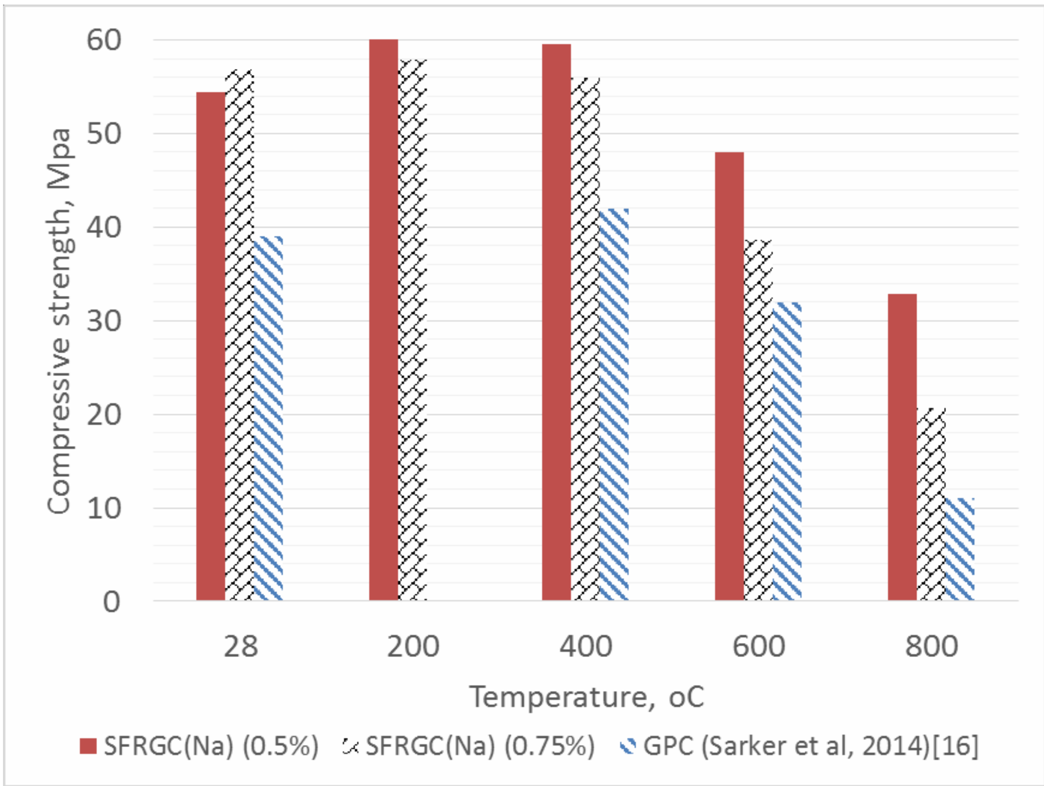
Figure 4.18 Correlation of Elastic modulus with compressive strength of SFRC, SFRGC(Na) and SFRGC(K).

4.3.5 Effect of Steel Fibres on the Compressive Strength

The effect of steel fibres on the compressive strength of SFRC and SFRGC(Na) at various elevated temperatures is also evaluated in this study and is shown in Fig. 4.19. It can be seen that by adding steel fibres the residual compressive strengths of SFRC at various elevated temperatures are increased significantly e.g.24%, 33%, 62% and 50% at 200^{0}C, 400^{0}C, 600^{0}C and 800^{O}C, respectively and the compressive strength increases with increase in fibre volume fractions irrespective of elevated temperatures. In the case of SFRGC(Na) significant improvement in residual compressive strength due to addition of steel fibre is also observed which are about 42%, 50% and >100% at 400^{0}C,600^{0}C and 800^{O}C, respectively. However, in this case the increase in steel fibre volume fraction from 0.5% to 075% did not show any improvement in the compressive strength at elevated temperatures and only show marginal improvement at ambient condition. This insignificant improvement even by increasing the steel fibre volume fraction by 50% could be due to poor dispersion of 60 mm long steel fibres in relatively highly viscous geopolymer concrete. The viscosity of Na-based geopolymer is much higher than that of OPC matrix and the steel fibres were in bundled form, therefore, the separation of bundled steel fibres at such high volume fraction might be affected in the viscous medium. However, more research at other volume fractions of this type of steel fibres need to be conducted further to identify the reason behind this insignificant improvement in compressive strength.



(a)



(b)

Figure 4.19 Effect of steel fibres on compressive strength of (a) ordinary portland cement (OPC) concrete and (b) geopolymer concrete containing Na-based alkali solutions at various elevated temperatures.

4.3.6 Comparison of experimental results with existing model and proposed a new model

Empirical model to predict the residual mechanical properties of concrete at various elevated temperatures is very useful in the design of concrete structures at fire. While several models for unreinforced concrete are available so far only one empirical model proposed by Aslani and Samali, (2014) is available to predict the mechanical properties of steel fibre reinforced concrete at elevated temperatures. No such empirical model yet to be reported for SFRGC at elevated temperatures. On the other hand Eurocode (2015) is available to predict the compressive strength of ordinary concrete at various elevated temperatures. In this paper the measured compressive strength, tensile strength and elastic modulus of all three fibre reinforced concretes at various elevated temperatures are compared with the existing model by

Aslani and Samali, (2014) and Eurocode (2015) and a simplified empirical model for SFRGCs are also proposed. Fig. 4.20 shows the comparison of measured compressive strength values with those predicted by Aslani and Samali's model and by Eurocode. It can be seen that the both models predict the compressive strength of SFRC reasonably well. However, the existing Eurocode for ordinary concrete underestimates the compressive strength at 600^{o}C and 800^{o}C. It can also be seen that in the case of fibre reinforced geopolymer concretes, both models underestimate the compressive strengths at elevated temperatures. Hence, a modified empirical equation shown in equation(1) is proposed for compressive strength of SFRGC and it can be seen that the predicted values are very close to the measured values as shown in Figs. 4.20b-c. Comparison of measured indirect tensile strength with those predicted by Aslani and Samali's model is also shown in Fig.4.21 and it can be seen that the existing model slightly underestimates the measured values for SFRC. However, in the case of SFRGCs the existing model significantly underestimates the measured values. Hence a modified empirical equation shown in equation (2) is proposed for in direct tensile strength of SFRC and SFRGCs and it can be seen that the predicted values are in close agreement with the measured values in the case of SFRC and SFRGC(Na). It can also be seen that in the case of elastic modulus the Aslani and Samali's model agrees well with the measured values for all three types of concretes. A simplified empirical model shown in equation(3) is also proposed to predict the elastic modulus of steel fibre reinforced concrete and geopolymer concretes and found to agree well with the measured values shown in Fig. 4.22.

$$f'_{cT} = f'_c\left\{1 + \frac{T}{1000} - 2 * \left(\frac{T}{1000}\right)^2\right\} \qquad (100^oC \le T \le 800^oC) \text{ Eqn. (1)}$$

$$f'_{tT} = f'_t\left\{1 + \frac{T}{1000} - \left(\frac{T}{1000}\right)^2\right\} \qquad (100^oC \le T \le 800^oC) \text{ Eqn. (2)}$$

$$E_{cT} = E_c\left\{1 - \left(\frac{T}{1000}\right)\right\} \qquad (100^oC \le T \le 800^oC) \text{ Eqn. (3)}$$

Where, f'_{cT} = Compressive strength at elevated temperature, T (MPa)

f'_{tT}= Indirect tensile strength at elevated temperature, T (MPa)

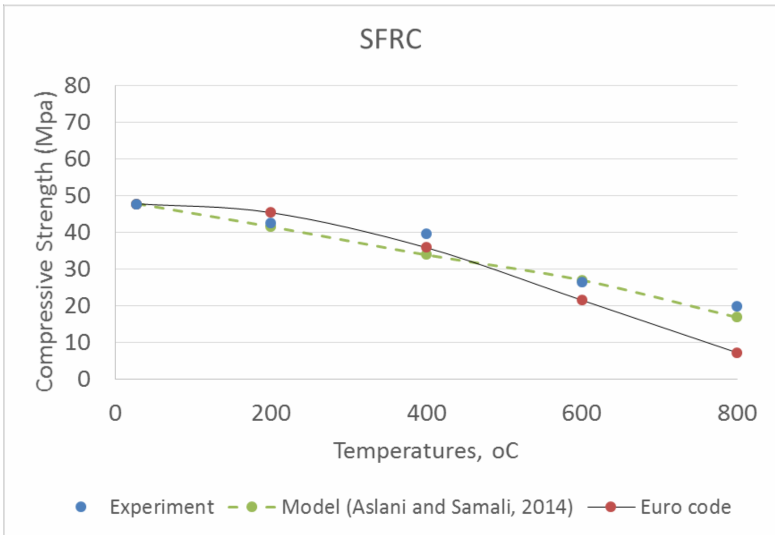
E_{cT} = Elastic modulus at elevated temperature, T (GPa)

f'_{c} = Compressive strength at ambient temperature (Mpa)

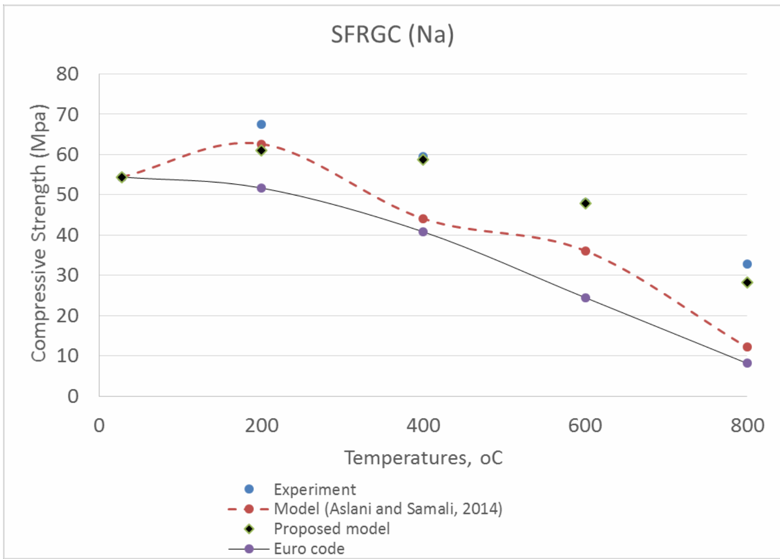
f'_{t} = Indirect tensile strength at ambient temperature (Mpa)

E_{c} = Elastic modulus at ambient temperature (GPa)

T = Elevated temperature in ^{o}C



(a)



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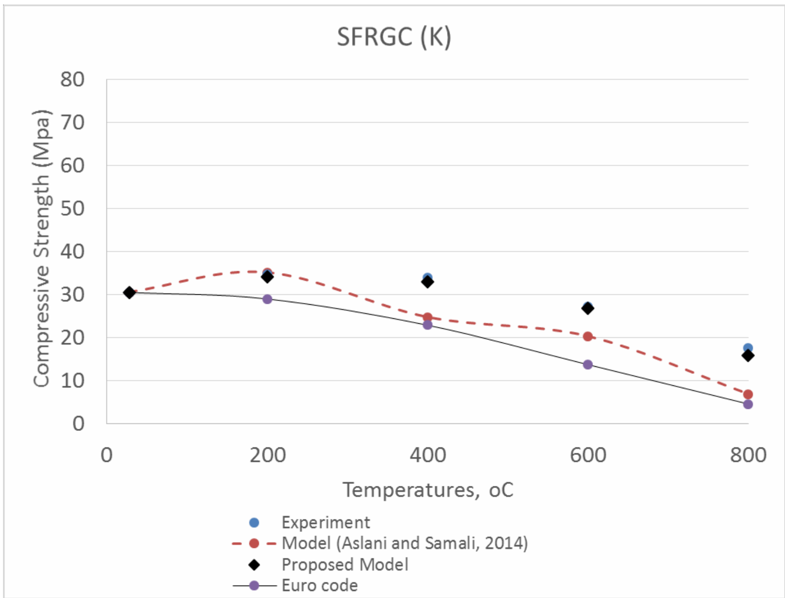
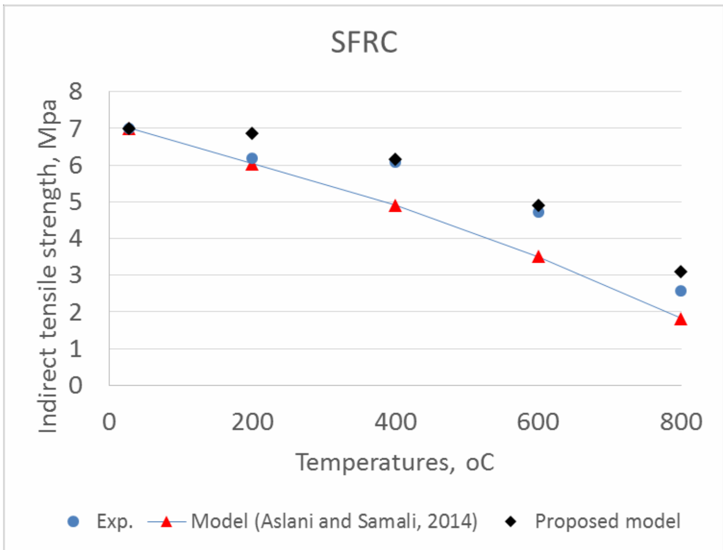
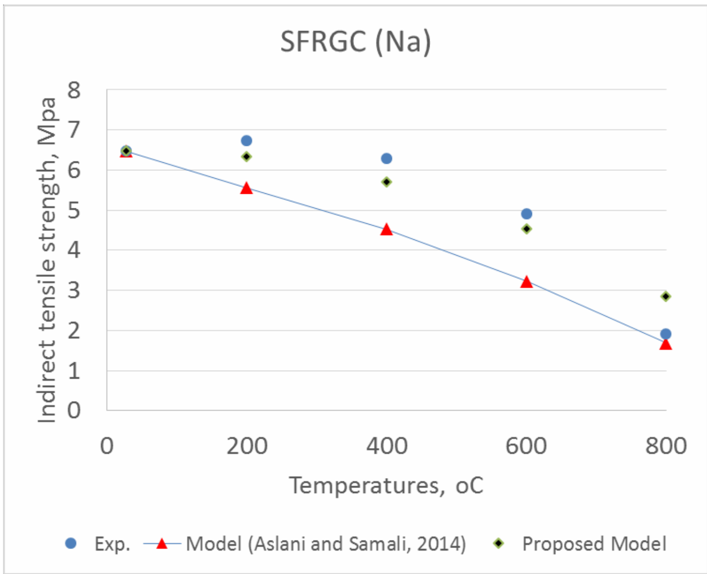


(c)

Figure 4.20 Comparison of experimentally measured compressive strengths of SFRC, SFRGC(Na) and SFRGC (K) with model.



(a)



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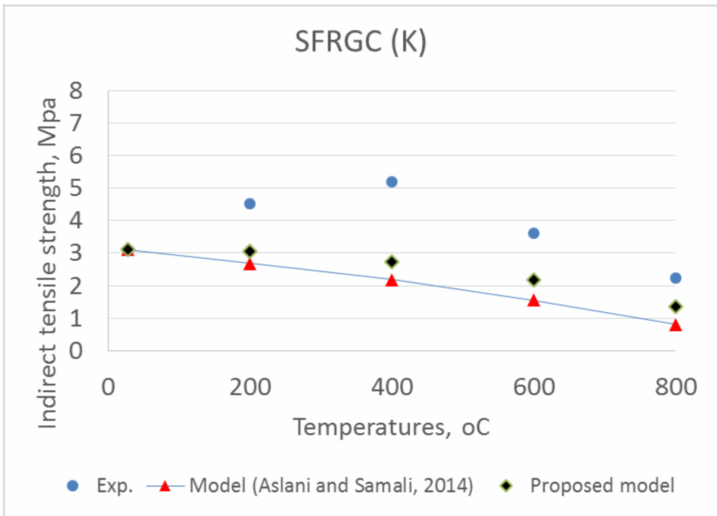
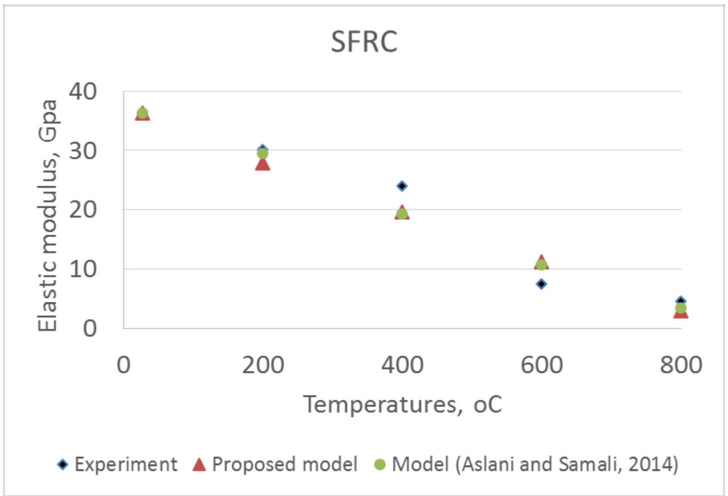
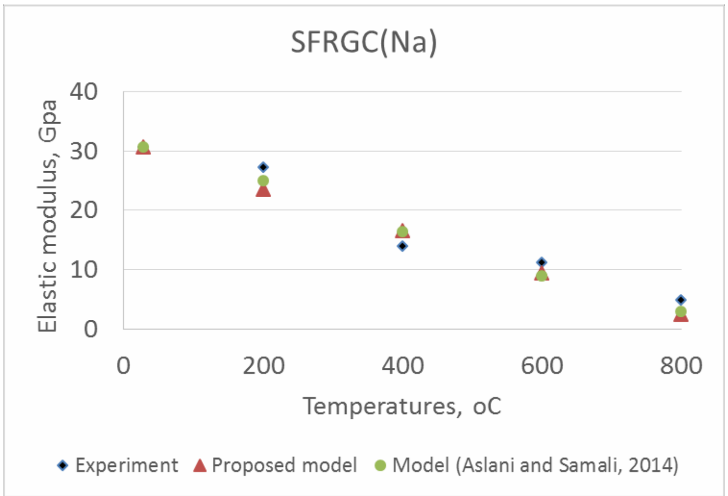


(c)

Figure 4.21 Comparison of experimentally measured indirect tensile strengths of SFRC, SFRGC(Na) and SFRGC(K) with model.



(a)



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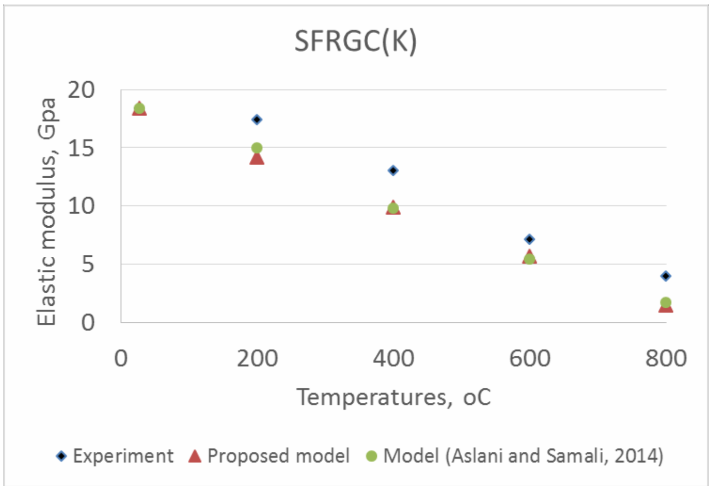


(c)

Figure 4.22 Comparison of experimentally measured elastic modulus of SFRC, SFRGC(Na) and SFRGC(K)with model.

4.3.7 Cracking and failure behaviour of concrete cylinders and the condition of steel fibres

The effects of elevated temperatures on cracking behaviour of SFRC, SFRGC(Na) and SFRGC(K) are shown in Fig. 4.23. It can be seen that up to 400°C no cracks are formed in all concretes. However, the SFRC showed signs of cracks at 600°C and it becomes worst at 800°C, where many wide cracks on the surface are formed. The SFRGCs, however, survived from major surface cracking at 800°C, but fine cracks are formed in few locations.

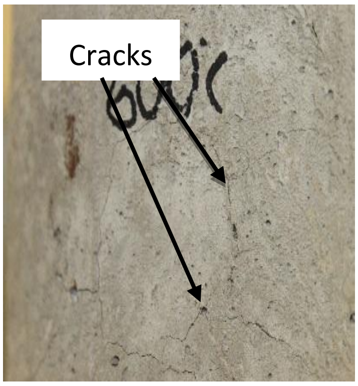
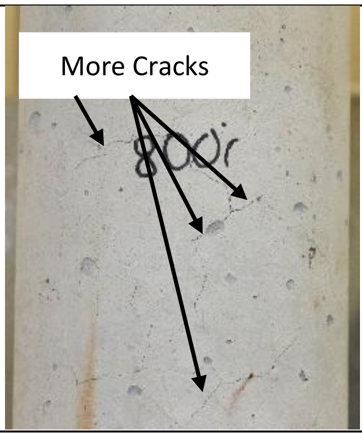
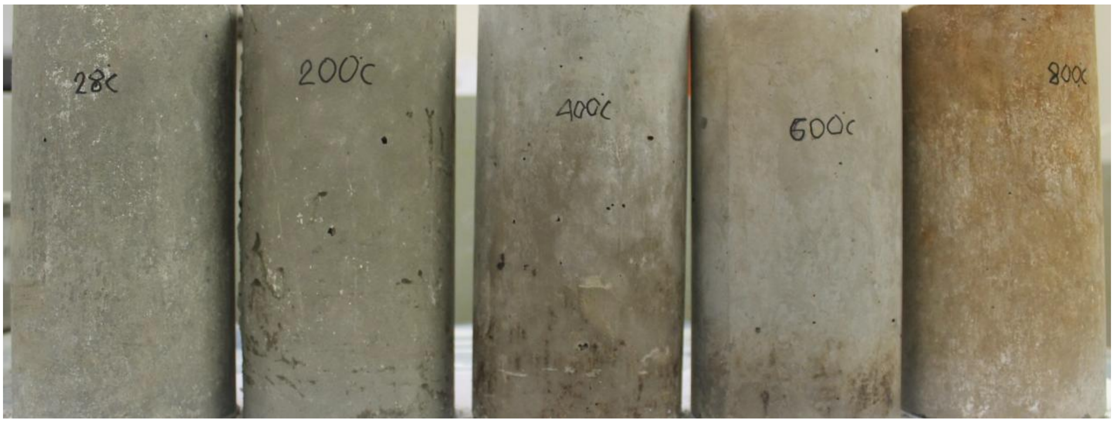
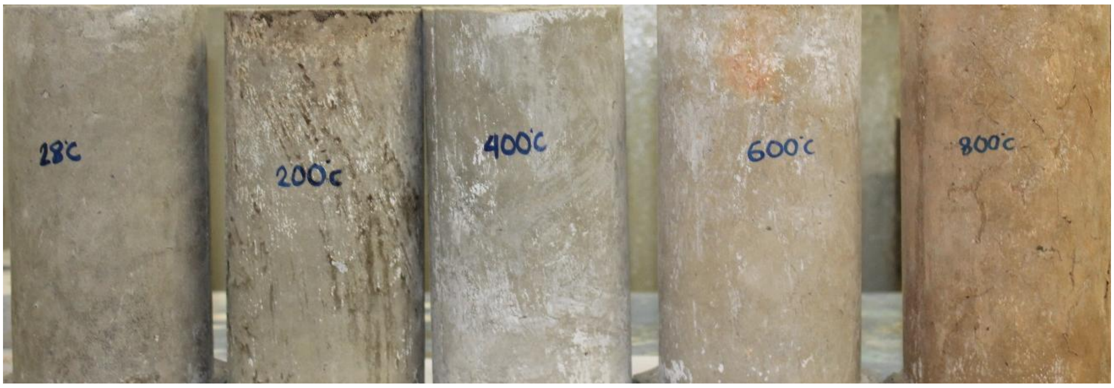
Temp.	SFRC	SFRGC(Na)	SFRGC(K)
400°C			
600°C			
800°C			

Figure 4.23 Surface cracking of SFRC, SFRGC(Na) and SFRGC(K) at 400°C, 600°C and 800°C.

Fig. 4.24 shows the change the colour of two types of geopolymer concretes after subjected to various elevated temperatures. It can be seen that the K-based geopolymer exhibited slightly more reddish colour than its Na-based counterpart. The failure behaviour of cylinders at ultimate compression load of all three types of concrete are studied and shown in Fig. 4.25. It can be seen fewer damage and spalling of concrete in SFRGC(Na) compared to its K-based counterpart and SFRC at ultimate compression load, the results which is consistent with the compressive strength values. At 600^{o}C and 800^{o}C the spalling of concrete in SFRGC(K) is very similar to the SFRC, which again coincides with the compressive strength results.



SFRGC(Na)



SFRGC(K)

Figure 4.24 Change in colour due to various elevated temperatures in Na- and K-based geopolymer concretes.

(a) SFRC

(b)SFRGC(Na)

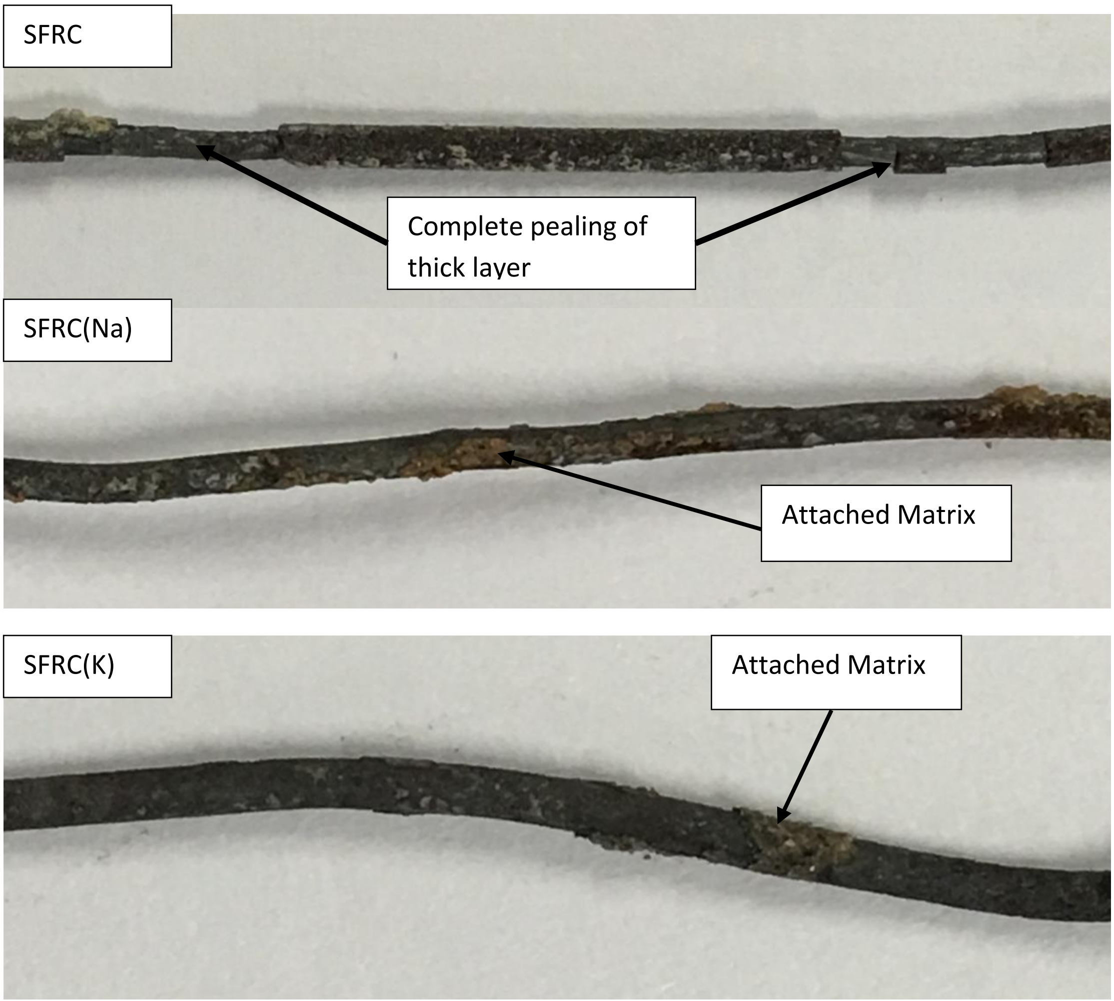
(c) SFRGC(K)

Figure 4.25 Failure of three types of steel fibres reinforced concretes at ultimate compression load after exposure to elevated temperatures of 200^{0}C, 400^{0}C, 600^{0}C and 800^{o}C.

Condition of fibres in fibre reinforced concrete after exposure to fire is always a concern especially for polymeric fibres. However, steel fibres may also damage due to elevated temperatures inside the concrete. As the fire resistance capacity of geopolymer is higher than the OPC binder, it is expected that the steel fibres experience fewer damage in the former than the latter .In this study, visual examination of the condition of steel fibres surface at 600^{o}C and 800^{O}C in all three concretes is conducted and is shown in Fig. 4.26. It can be seen that the steel fibre shows sign of surface layer pealing in OPC concrete at 600^{O}C. However, at the same temperature no such pealing of surface layer of steel fibre can be seen in both geopolymers. At 800^{O}C, complete removal of a thick layer of steel fibre can be seen in OPC concrete, while no such damage of steel fibre is observed in the case of both geopolymers as shown in Fig.4.26. This examination also reveals that the possibility of damage of steel fibres due to elevated temperatures during fire is much lower in geopolymer than in OPC binder, which also reflected in the measured mechanical properties of this study.

(a) Plain Fibre

(b) 600^{o}C



(c) 800°C

Figure 4.26 Steel fibre conditions in three types of concretes after exposure to 600^{0}C and 800^{0}C temperatures.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Review of the Work

This research was conducted to evaluate the effects of different elevated temperatures on the residual mechanical properties of steel fibre reinforced geopolymer concretes containing sodium and potassium based alkali activators (SFRGC(Na) and SFRGC(K)) and comparing with those of steel fibre OPC concrete (SFRC). To evaluate this, the effect of different ratios of alkali activator on geopolymer pastes synthesized by Na- and K-based activator was analyzed. The first part of this research determined the optimum silicate to hydroxide ratio of both alkali activators to get the maximum residual compressive strength of geopolymer pastes after exposure to elevated temperatures. Post heating physical behavior and microstructural behavior of geopolymer pastes were analyzed to support those results of compressive strengths. The second part determined the compressive strength, indirect tensile strength and elastic modulus of steel fibre reinforced geopolymer concretes (SFRGC) of both alkali activators and those of SFRC. The effects of steel fibres on above mechanical properties of those three types of concretes at elevated temperatures are also evaluated in this study. The cracking and failure behavior of SFRGC(Na) and SFRGC(K) concretes at various elevated temperatures are also studied and compared with that of SFRC. The condition of steel fibres in SFRGC(Na) and SFRGC(K) concretes after exposure to elevated temperatures of 600^{o}C and 800^{o}C is also examined and compared with those in SFRC. The experimental results of above three types of concretes are also compared with existing models/codes and simplified empirical equations for mechanical properties of steel fibre reinforced geopolymer concrete are also proposed.

5.2 Summary of Findings

From the experimental and analytical studies of geopolymer paste and steel fibre reinforced geopolymer concrete following findings can be summarized.

5.2.1 Effect of elevated temperatures on geopolymer pastes

Based on limited experimental variables in terms of Na- and K-based activators, the ratios of silicate to hydroxide of above activators, elevated temperatures on the residual compressive strengths, volumetric shrinkage and mass loss of geopolymer pastes the following conclusions can be drawn:

1. The geopolymer pastes containing Na-based activator exhibited higher compressive strength at ambient temperature and higher compressive strength at elevated temperatures up to 400^oC than its K-based counterpart.
2. At 600^oC the compressive strength of geopolymer containing K-based activator is slightly higher than its Na-based counterpart.
3. The geopolymer paste containing K-based activator exhibited higher residual compressive strengths at all elevated temperatures compared to ambient temperature than its Na-based counterpart.
4. The geopolymer paste containing K-based activator with K_2SiO_3/KOH ratio of 3 exhibited the highest residual compressive strengths at all elevated temperatures compared to ambient temperature than its Na-based counterpart.
5. The volumetric shrinkage and mass loss of geopolymer paste containing K-based activator is lower than its Na-based counterpart.
6. The geopolymer pastes containing K-based activator exhibited fewer surface cracks than that of Na-based activator.
7. XRD peaks of quartz and mullite are observed in both geopolymers after exposure to 400 and 800^oC temperatures like those observed in ambient condition. The presences of quartz and mullite peaks are believed to be the reason for maintaining residual compressive strength by both geopolymers after exposure to elevated temperatures.

8. The Na-based fly ash geopolymer exhibited higher weight loss in TGA and higher DTA peak at about 100^{o}C than its K-based counterpart after exposure to 400^{o}C. The higher weight loss and DTA peak is associated with the loss of absorbed and combined water in geopolymer gels, which indicate that higher geopolymer gels are remained in Na-based geopolymer after 400^{o}C exposure than K-based system, which agrees well with the observed compressive strength results. An opposite trend is observed after exposure to 800^{o}C.

5.2.2 Effect of elevated temperatures on steel fibre reinforced geopolymer concrete

The following conclusions can be made after analysis of all test results of steel fibre reinforced geopolymer concrete and steel fibre reinforced concrete:

1. Steel fibres reinforced geopolymer concretes (SFRGC(Na) and SFRGC(K)) exhibited much higher residual compressive strength capacity at elevated temperatures compared to their original ambient temperature strengths than that of SFRC. Both geopolymer concretes retained their original compressive strength up to about 400^{o}C, whereas the SFRC showed continued reduction of its original compressive strength by about 30% at 400^{o}C. After this temperature the rate of original compressive strength loss is very similar in all three concretes.
2. In case of indirect tensile strength, the SFRGC(K) exhibited much higher retention capacity (about 65%) of its original strength at elevated temperatures up to about 400^{o}C compared to its Na-based counterpart concrete and SFRC. The SFRGC(K) showed marginal increase of its original tensile strength at 200^{o}C and showed gradual reduction of its original tensile strength with increase in elevated temperatures.
3. The steel fibre reinforced geopolymer concretes containing sodium and potassium based alkali activator exhibited lower elastic modulus at elevated temperatures than that of SFRC. The rate of loss of elastic modulus at various

elevated temperatures of both steel fibre reinforced geopolymer concretes compared to their original elastic modulus is very similar to that of SFRC.

4. Strong correlations of compressive strength with indirect tensile strength and elastic modulus of SFRC at elevated temperatures is observed. However, in the case of SFRGC(Na) and SFRGC(K) no such strong correlations are observed.
5. The addition of steel fibres increased the compressive strength of ordinary concrete and geopolymer concrete containing Na-based alkali activators at ambient temperature. With increase in elevated temperatures the residual compressive strengths of ordinary concrete and geopolymer concrete containing Na-based alkali activators also increases due to addition of steel fibres.
6. The existing model of steel fibre reinforced concrete and Eurocode model for ordinary concrete underestimate the compressive strength of both SFRGC(Na) and SFRGC(K) concretes. In the case of tensile strength, the existing model of steel fibre reinforced concrete also underestimates the strength of both SFRGC(Na) and SFRGC(K) concretes. The existing model of steel fibre reinforced concrete is found to predict the elastic modulus of both SFRGC(Na) and SFRGC(K) concretes reasonably well. Empirical equations to predict the residual compressive strength, tensile strength and elastic modulus of both SFRGC(Na) and SFRGC(K) concretes are also proposed.
7. Both SFRGC(Na) and SFRGC(K) concretes exhibited fewer surface cracking at elevated temperatures than SFRC. The SFRGC(Na) and SFRGC(K) concretes also showed fewer spalling at ultimate compression load after exposure to various elevated temperatures than that of SFRC. The steel fibres survived at elevated temperatures in both SFRGC(Na) and SFRGC(K) concretes than in SFRC where damage of top layer of steel fibre is noticed.

5.3 Recommendation for Further Study

From the results and conclusions reported from the analysis, following recommendations for the further studies are included:

1. The effect of alkali activators on geopolymer paste have been examined only by 8M concentration of sodium and potassium hydroxide in this study. More study should be conducted by 10M and 12M of concentration.
2. The experimental work done on the residual mechanical properties such as compressive strengths, indirect tensile strengths and elastic modulus of geopolymer concrete should be validated by flexural strengths as well.
3. The effect of steel fibre on the mechanical properties of geopolymer concretes have been studied in this study. However, the effect of other fibres such as carbon, basalt and their hybrid combination should be examined in the future study.
4. In this study, Ordinary Portland cement is 100% replaced by fly ash. It is recommended to carry out an experimental study by adding nano particles as the replacement of fly ash.

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APPENDIX A

Results of different tests of pastes and concretes

A.1 Compressive strength results of Na-based geopolymer paste mixtures after exposure to elevated temperatures of 200, 400, 600, and 800^{o}C.

A.1.1 Compressive strengths of Na-based geopolymer pastes at ambient temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2	1	50.4x51.4x50.5	98.5	38.62	53.59
	2	50.9x51.4x50.5	152	58.09	
	3	50.6x51.0x50.6	120	46.50	
	4	50.8x51.0x50.6	154	59.44	
	5	50.6x51.4x51.4	132	50.75	
	6	50.6x51.0x50.7	113	43.79	

A.1.2 Compressive strengths of Na-based geopolymer pastes at 200^{o}C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2	1	50.2x51.5x50.5	96.20	37.21	58.35
	2	50.4x51.5x50.2	134.32	51.75	
	3	50.7x50.8x50.3	82.5	32.03	
	4	51.0x50.5x50.5	172.7	67.05	
	5	50.3x50.0x50.8	98.3	39.08	
	6	50.3x51.2x50.7	146.7	56.96	

A.1.3 Compressive strengths of Na-based geopolymer pastes at 400^{o}C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2	1	50.4x50.8x50.5	76.3	30.03	55.71
	2	50.7x50.0x50.5	169.5	66.86	
	3	50.0x50.3x50.9	157.0	62.42	
	4	50.4x50.0x50.6	114	45.18	
	5	50.2x50.0x51.4	121.5	48.40	
	6	50.0x49.7x50.7	78.7	31.35	

A.1.4 Compressive strengths of Na-based geopolymer pastes at 600°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2	1	49.4x50x49.9	149	60.32	52.20
	2	50.1x49.5x49.3	121	48.79	
	3	49.2x48.3x49.2	120	50.5	
	4	49.7x50.1x49.7	128	51.40	
	5	49.2x49.5x49.0	139	50.07	
	6	49.1x49.7x49.1	127.5	52.24	

A.1.5 Compressive strengths of Na-based geopolymer pastes at 800°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2	1	49.5x48.8x50	54	22.35	24.78
	2	49.0x49.5x49.4	59	24.32	
	3	49.5x49.0x48.1	65	26.80	
	4	49.0x49.0x48.5	65	27.07	
	5	50x48.7x48.5	57	23.40	
	6	48.8x48.5x49.6	28.5	-	

A.1.6 Compressive strengths of Na-based geopolymer pastes at ambient temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2.5	1	51.0x50.3x51.1	98.0	38.20	55.95
	2	50.8x50.4x50.4	95.0	37.10	
	3	50.6x52.0x50.9	133.0	50.50	
	4	50.7x52.0x50.6	168.0	63.72	
	5	50.8x50.9x50.9	141.0	54.53	
	6	51.1x51.7x50.4	145.5	55.07	

A.1.7 Compressive strengths of Na-based geopolymer pastes at 200°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2.5	1	51.2x49.9x50.2	180	70.49	62.33
	2	50.3x51.5x50.6	206	79.52	
	3	51.0x50.2x50.6	130	50.78	
	4	50.0x52.0x50.8	255	-	
	5	51.1x50.0x50.1	201	78.66	
	6	50.3x51.5x50.5	84	32.42	

A.1.8 Compressive strengths of Na-based geopolymer pastes at 400°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2.5	1	50.9x49.4x49.8	162.5	64.62	49.78
	2	49.6x49.7x49.1	71.10	-	
	3	49.4x50.1x59.7	70.0	-	
	4	50.7x49.7x49.5	111.5	44.25	
	5	49.3x49.5x50.3	121.0	49.58	
	6	50.6x50.5x50.5	138.0	54.0	

A.1.9 Compressive strengths of Na-based geopolymer pastes at 600°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2.5	1	50x49.3x49.4	137	55.58	49.04
	2	49.6x49.4x49.3	135	55.09	
	3	49.2x50.2x49.5	99	40.08	
	4	49.5x49.6x49.4	127	51.72	
	5	50.0x49.0x49.2	105.5	43.06	
	6	49.1x49.3x49.5	118	48.75	

A.1.10 Compressive strengths of Na-based geopolymer pastes at 800°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-2.5	1	48.9x48.7x49.5	67.6	28.38	25.40
	2	48.6x49.7x50.3	61.6	25.5	
	3	49.0x48.8x48.7	67.5	28.22	
	4	49.0x49.4x48.1	59.8	25.0	
	5	49.0x48.8x48.5	50.3	21.03	
	6	49.3x49.3x48.2	59.2	24.35	

A.1.11 Compressive strengths of Na-based geopolymer pastes at ambient temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-3	1	51.2x50.4x50.5	64	-	39.47
	2	50x50.6x50.7	106	41.89	
	3	50.5x50.3x50.6	94.5	37.20	
	4	51.0x50.6x51.3	96.0	37.20	
	5	50.7x50.7x506	103.5	40.26	
	6	51.2x51.5x50.3	107.7	40.77	

A.1.12 Compressive strengths of Na-based geopolymer pastes at 200°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-3	1	49.5x50.2x51.1	46.5	-	53.35
	2	49.8x51x51.5	123.5	48.62	
	3	50x50.1x50.2	108.0	43.11	
	4	50.0x50.2x50.1	172.0	68.52	
	5	49.8x50.6x50.5	134.0	53.17	
	6	49.8x50x50.0	81.5	-	

A.1.13 Compressive strengths of Na-based geopolymer pastes at 400°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-3	1	49.8x49.6x49.6	170	-	51.68
	2	49.8x49.6x49.5	125	50.6	
	3	49.9x49.0x50.0	129	52.75	
	4	49.8x50.2x49.8	134	53.60	
	5	49.6x49.7x49.8	109	44.22	
	6	49.6x49.3x50.4	140	55.25	

A.1.14 Compressive strengths of Na-based geopolymer pastes at 600°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-3	1	49.9x49.8x50	102	41.04	49.86
	2	49.3x49.0x49.5	136	56.29	
	3	49.5x49.5x49.5	138	56.32	
	4	49.0x49.2x49.8	120	49.78	
	5	49.5x49.5x49.4	104	42.44	
	6	49.4x49.0x49.2	129	53.29	

A.1.15 Compressive strengths of Na-based geopolymer pastes at 800°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
Na-3	1	49.0x48.5x49.0	45.5	19.14	25.15
	2	49.1x49.1x49.0	65.0	26.96	
	3	49.0x48.7x49.2	71.0	29.75	
	4	49.4x49.0x48.6	70.5	29.12	
	5	49.0x48.5x49.2	42.0	17.67	
	6	49.4x49.0x49.6	68.4	28.25	

A.2 Compressive strength results of K-based geopolymer paste mixtures after exposure to elevated temperatures of 200, 400, 600, and 800^{o}C.

A.2.1 Compressive strengths of K-based geopolymer pastes at ambient temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2	1	50.2x50.1x50.4	84.0	33.4	36.97
	2	49.3x50.7x50.5	84.0	33.60	
	3	49.4x50.6x50.8	87.5	35.0	
	4	50.8x50.1x50.1	125.5	49.31	
	5	50.2x50.1x50.5	90.5	35.98	
	6	50.4x50.5x50.5	88.0	34.57	

A.2.2 Compressive strengths of K-based geopolymer pastes at 200^{o}C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2	1	50.0x49.5x50.2	90.0	36.36	38.42
	2	49.8x50.1x50.2	120.0	48.09	
	3	50.2x50.4x50.6	98.0	38.73	
	4	50.2x49.4x50.5	88.0	35.48	
	5	50.2x50.3x50.0	79.0	31.28	
	6	50.7x50.8x50.2	104.5	40.57	

A.2.3 Compressive strengths of K-based geopolymer pastes at 400^{o}C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2	1	49.1x49.5x49.5	132.5	54.51	53.13
	2	49.7x49.0x49.8	102.5	42.08	
	3	50.1x50.0x50.0	139.0	55.49	
	4	49.5x49.7x50.1	132.0	53.65	
	5	49.4x49.6x49.8	65.5	-	
	6	50.1x50.1x50.2	150.5	59.95	

A.2.4 Compressive strengths of K-based geopolymer pastes at 600^{o}C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2	1	50.1x49.5x50.0	142.0	57.25	58.25
	2	49.5x50.2x49.7	157.5	63.38	
	3	49.7x49.5x49.7	138.5	56.29	
	4	49.8x49.6x50.2	167.5	67.81	
	5	49.5x49.5x49.6	108.5	44.28	
	6	49.8x49.8x49.6	150.0	60.48	

A.2.5 Compressive strengths of K-based geopolymer pastes at 800^{o}C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2	1	48.2x48.0x48.4	74.5	32.20	33.28
	2	48.6x48.7x49.1	64.0	27.04	
	3	49.0x48.8x49.6	93.5	39.10	
	4	48.5x48.8x48.4	78.0	32.96	
	5	49.1x49.0x48.8	80.5	33.46	
	6	48.9x49.8x49.5	85.0	34.70	

A.2.6 Compressive strengths of K-based geopolymer pastes at ambient temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2.5	1	50.8x49.5x50.2	62.0	24.65	28.08
	2	50.1x50.0x50.1	68.0	27.14	
	3	50.4x50.3x50.4	69.0	27.21	
	4	50.1x50.1x50.2	88.0	35.06	
	5	50.2x49.8x50.2	75.0	30.0	
	6	50.2x49.8x50.0	61.0	24.40	

A.2.7 Compressive strengths of K-based geopolymer pastes at 200°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2.5	1	50.2x50.3x50.5	103.0	40.80	31.26
	2	50.4x50.5x50.2	65.0	25.54	
	3	50.0x50.2x51.1	69.0	27.49	
	4	50.6x50.2x50.4	65.0	25.60	
	5	50.4x50.3x49.9	62.0	24.45	
	6	50.1x50.2x51.0	110.0	43.73	

A.2.8 Compressive strengths of K-based geopolymer pastes at 400°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2.5	1	49.8x49.9x50.0	151.0	60.76	42.89
	2	49.7x49.2x49.4	73.0	29.85	
	3	49.4x49.9x50.1	93.0	37.73	
	4	50.0x49.8x50.0	68.0	27.30	
	5	49.9x49.0x49.9	115.0	47.03	
	6	49.8x49.2x50.4	134.0	54.69	

A.2.9 Compressive strengths of K-based geopolymer pastes at 600°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2.5	1	50.8x49.8x49.8	110.0	43.48	40.60
	2	50.0x50.2x49.7	108.0	43.02	
	3	49.7x49.7x49.6	86.0	34.81	
	4	49.8x49.8x49.4	102.0	41.10	
	5	49.8x50.1x49.8	47.0	-	
	6	50.0x49.7x49.7	66.0	-	

A.2.10 Compressive strengths of K-based geopolymer pastes at 800°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-2.5	1	49.2x49.0x49.5	51.0	21.15	26.60
	2	49.6x48.9x48.4	76.0	31.33	
	3	48.5x49.1x48.7	67.0	27.72	
	4	48.9x49.0x48.8	62.0	25.88	
	5	48.9x49.0x49.2	59.0	25.62	
	6	49.0x49.5x48.9	70.0	28.86	

A.2.11 Compressive strengths of K-based geopolymer pastes at ambient temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-3	1	50.2x50.5x50.8	78.0	30.77	29.26
	2	50.4x50.2x50.7	72.0	28.46	
	3	50.2x50.0x50.6	71.0	28.28	
	4	50.3x50.5x50.2	80.0	31.50	
	5	50.0x50.2x50.5	68.5	27.30	
	6	50.1x49.8x50.0	48.5	-	

A.2.12 Compressive strengths of K-based geopolymer pastes at 200°C temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-3	1	50.2x50.0x50.1	84.0	33.47	31.20
	2	50.2x49.5x50.2	35.5	-	
	3	50.0x50.0x50.8	80.0	32.0	
	4	50.6x50.0x50.5	91.0	35.97	
	5	50.4x50.2x50.8	70.5	27.86	
	6	50.1x50.5x50.2	67.5	26.67	

A.2.13 Compressive strengths of K-based geopolymer pastes at 400ºC temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-3	1	49.8x49.0x50.0	94.5	38.73	35.94
	2	50.1x49.5x49.6	50.0	-	
	3	50.5x49.2x50.2	99.0	39.84	
	4	49.6x50.0x50.0	91.0	36.70	
	5	49.9x49.6x50.1	90.0	36.36	
	6	49.8x50.1x49.9	70.0	28.05	

A.2.14 Compressive strengths of K-based geopolymer pastes at 600ºC temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-3	1	50.0x49.2x50.0	87.5	35.6	36.98
	2	49.6x49.8x50.0	79.0	32.0	
	3	49.9x49.3x49.8	90.0	36.58	
	4	49.8x49.5x49.9	102.5	41.60	
	5	49.8x50.0x49.8	99.0	39.75	
	6	49.0x50.2x50.3	89.5	36.38	

A.2.15 Compressive strengths of K-based geopolymer pastes at 800ºC temperature

Series	Specimen No.	Size(mm)	Ultimate Load, KN	Compressive strength (MPa)	Average strength (MPa)
K-3	1	49.2x48.6x49.5	26.5	-	30.58
	2	48.9x49.0x49.0	61.5	25.67	
	3	48.6x48.8x49.9	66.0	27.82	
	4	48.9x48.8x49.0	79.4	33.27	
	5	48.7x48.8x49.5	73.0	30.72	
	6	48.8x48.0x49.1	83.0	35.43	

A.3 Mass loss results of Na-based geopolymer paste after exposure to elevated temperatures.

A.3.1 Mass loss results of Na-based geopolymer paste at 200°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2	1	233.27	223.23	10.04	11.44
	2	236.49	224.25	12.24	
	3	237.32	227.12	10.20	
	4	235.01	223.03	11.98	
	5	227.47	216.48	10.99	
	6	240.76	227.56	13.20	

A.3.2 Mass loss results of Na-based geopolymer paste at 400°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2	1	233.32	211.30	22.02	21.95
	2	235.29	214.85	20.44	
	3	234.65	212.24	22.41	
	4	235.49	213.44	22.25	
	5	234.58	212.59	22.00	
	6	234.20	211.63	22.57	

A.3.3 Mass loss results of Na-based geopolymer paste at 600°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2	1	234.74	209.58	25.18	26.58
	2	237.56	210.10	27.46	
	3	238.30	210.19	28.11	
	4	233.10	209.12	23.98	
	5	234.45	209.31	25.14	
	6	239.90	210.28	29.62	

A.3.4 Mass loss results of Na-based geopolymer paste at 800°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2	1	235.53	209.13	26.40	26.26
	2	242.48	215.28	27.20	
	3	235.79	204.83	25.96	
	4	236.04	209.63	26.41	
	5	236.24	210.60	25.64	
	6	240.04	214.41	25.63	

A.3.5 Mass loss results of Na-based geopolymer paste at 200°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2.5	1	240.03	222.34	17.69	16.89
	2	242.73	226.65	16.08	
	3	241.12	224.81	16.31	
	4	242.72	224.59	18.13	
	5	239.14	221.80	17.30	
	6	244.49	228.49	16.00	

A.3.6 Mass loss results of Na-based geopolymer paste at 400°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2.5	1	245.37	219.21	26.16	25.71
	2	237.39	212.71	24.68	
	3	242.57	215.62	26.95	
	4	242.52	217.17	25.35	
	5	236.16	210.24	25.92	
	6	240.97	215.74	28.23	

A.3.7 Mass loss results of Na-based geopolymer paste at 600^{o}C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2.5	1	237.90	210.75	27.15	26.36
	2	238.96	217.38	26.58	
	3	241.66	215.46	26.20	
	4	240.79	213.71	27.08	
	5	237.11	211.08	26.03	
	6	233.84	208.70	25.14	

A.3.8 Mass loss results of Na-based geopolymer paste at 800^{o}C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-2.5	1	235.29	208.71	26.58	27.86
	2	240.08	212.45	27.63	
	3	238.80	211.11	27.69	
	4	242.38	213.38	29.00	
	5	237.69	209.49	28.20	
	6	235.05	207.00	28.05	

A.3.9 Mass loss results of Na-based geopolymer paste at 200^{o}C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-3	1	238.15	220.13	18.02	16.83
	2	238.02	221.47	16.55	
	3	236.47	220.10	16.37	
	4	234.60	217.45	17.15	
	5	244.43	227.64	16.79	
	6	236.12	220.00	16.12	

A.3.10 Mass loss results of Na-based geopolymer paste at 400^oC temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-3	1	238.06	213.56	24.50	24.77
	2	239.74	214.33	25.44	
	3	241.88	216.94	24.94	
	4	239.64	213.41	26.23	
	5	234.70	211.21	23.49	
	6	238.96	214.94	24.02	

A.3.11 Mass loss results of Na-based geopolymer paste at 600^oC temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-3	1	242.72	216.02	26.70	26.55
	2	231.85	206.50	25.35	
	3	241.27	213.41	27.86	
	4	241.50	214.86	26.64	
	5	236.35	210.32	26.03	
	6	237.07	210.36	26.71	

A.3.12 Mass loss results of Na-based geopolymer paste at 800^oC temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
Na-3	1	240.98	214.41	26.57	27.62
	2	241.27	213.54	27.73	
	3	244.75	215.93	28.82	
	4	243.72	215.15	28.57	
	5	242.61	214.16	28.45	
	6	234.33	208.71	25.62	

A.4 Mass loss results of K-based geopolymer paste after exposure to elevated temperatures.

A.4.1 Mass loss results of K-based geopolymer paste at 200°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2	1	230.64	214.08	16.53	13.5
	2	227.27	216.13	11.14	
	3	231.21	219.28	11.93	
	4	231.26	215.55	15.71	
	5	227.24	216.53	10.81	
	6	230.38	215.54	14.84	

A.4.2 Mass loss results of K-based geopolymer paste at 400°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2	1	231.26	211.05	20.21	20.37
	2	227.27	207.41	19.86	
	3	231.21	210.78	20.43	
	4	227.24	208.21	19.03	
	5	230.61	207.94	22.67	
	6	230.38	210.35	20.03	

A.4.3 Mass loss results of K-based geopolymer paste at 600°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2	1	239.75	213.79	25.96	24.00
	2	236.61	211.33	25.28	
	3	235.60	212.55	23.05	
	4	231.77	208.28	23.49	
	5	230.09	207.97	22.12	
	6	209.59	209.59	24.08	

A.4.4 Mass loss results of K-based geopolymer paste at 800°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2	1	232.50	209.43	23.07	23.61
	2	231.44	207.14	24.30	
	3	234.48	210.02	24.46	
	4	231.38	209.71	21.67	
	5	239.53	214.06	25.47	
	6	238.95	216.26	22.69	

A.4.5 Mass loss results of K-based geopolymer paste at 200°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2.5	1	234.61	220.66	13.95	13.02
	2	231.65	218.99	12.66	
	3	233.23	221.77	11.46	
	4	229.46	216.99	12.47	
	5	231.97	217.80	14.17	
	6	234.77	221.36	13.41	

A.4.6 Mass loss results of K-based geopolymer paste at 400°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, Gm
K-2.5	1	228.03	208.31	19.72	17.82
	2	220.75	203.41	17.34	
	3	224.85	209.34	15.51	
	4	226.96	209.52	17.44	
	5	225.27	206.96	18.31	
	6	227.04	208.44	18.60	

A.4.7 Mass loss results of K-based geopolymer paste at 600°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2.5	1	232.72	215.29	17.43	20.84
	2	236.46	213.54	22.90	
	3	234.55	210.37	24.18	
	4	230.12	212.33	17.79	
	5	233.55	211.21	22.34	
	6	232.50	212.05	20.45	

A.4.8 Mass loss results of K-based geopolymer paste at 800°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-2.5	1	231.00	208.12	22.88	21.05
	2	228.81	209.00	19.81	
	3	226.47	211.28	15.19	
	4	230.79	209.56	21.23	
	5	231.14	211.72	19.42	
	6	233.30	211.38	21.92	

A.4.9 Mass loss results of K-based geopolymer paste at 200°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-3	1	232.97	216.75	16.22	13.90
	2	227.29	212.85	14.44	
	3	230.43	217.63	12.80	
	4	225.70	211.96	13.74	
	5	226.56	214.08	12.48	
	6	232.97	219.27	13.70	

A.4.10 Mass loss results of K-based geopolymer paste at 400°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-3	1	225.52	209.69	15.83	18.35
	2	223.71	206.82	17.12	
	3	231.94	212.19	19.75	
	4	231.45	211.53	19.92	
	5	231.73	212.52	19.21	
	6	231.86	213.62	18.24	

A.4.11 Mass loss results of K-based geopolymer paste at 600°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, Gm
K-3	1	224.39	206.34	17.65	17.43
	2	227.06	209.38	17.68	
	3	227.51	209.75	17.76	
	4	227.28	209.74	17.54	
	5	225.45	208.31	17.14	
	6	227.85	211.02	16.83	

A.4.12 Mass loss results of K-based geopolymer paste at 800°C temperature.

Series	Specimen No.	Wt. before exposure, gm	Wt. after exposure, gm	Mass loss, gm	Average mass loss, gm
K-3	1	232.62	208.49	24.13	22.80
	2	237.00	211.91	25.09	
	3	231.75	207.54	24.21	
	4	229.33	209.03	20.30	
	5	235.45	210.68	24.77	
	6	224.23	205.79	18.44	

A.4 Compressive strength results of SFRC, SFRGC(Na) and SFRGC(K) after exposure to different elevated temperatures.

A.4.1 Compressive strength results of SFRC after exposure to different elevated temperatures.

Specimen No.	Temperature °C	Weight (gm)	Compressive strength , MPa	Average strength, MPa	Residual strength (%)
1	0	3855	50.92	47.73	-
2		3946	52.13		
3		3867	44.82		
4		3795	43.05		
1	200	3834	36.16	42.06	89.25
2		3810	39.06		
3		3840	43.49		
4		3935	55.66		
1	400	3953	71.68	39.67	83.11
2		3909	39.09		
3		3833	41.79		
4		3804	38.13		
1	600	3820	26.18	26.50	55.50
2		3904	20.88		
3		3955	26.21		
4		3847	32.64		
1	800	3929	22.0	19.92	41.73
2		3838	18.35		
3		3840	17.60		
4		3864	21.73		

A.4.2 Compressive strength results of SFRGC(Na) after exposure to different elevated temperatures.

Specimen No.	Temperature °C	Weight (gm)	Compressive strength , MPa	Average strength, MPa	Residual strength %
1	0	3820	59.23	54.42	-
2		3759	51.93		
3		3773	53.33		
4		3781	53.20		
1	200	3783	67.77	67.53	124
2		3769	70.5		
3		3814	64.34		
4		-	-		
1	400	3843	55.52	59.56	109.44
2		3826	58.93		
3		3870	64.43		
4		3821	59.37		
1	600	3800	51.31	48.03	88.25
2		3798	48.75		
3		3836	48.85		
4		3780	46.22		
1	800	3859	30.64	32.89	60.43
2		3768	32.94		
3		3834	33.81		
4		3869	33.17		

A.4.3 Compressive strength results of SFRGC(K) after exposure to different elevated temperatures.

Specimen No.	Temperature ºC	Weight (gm)	Compressive strength , MPa	Average strength, MPa	Residual strength %
1	0	3838	30.54	30.51	-
2		3846	29.74		
3		3824	30.07		
4		3859	30.52		
1	200	3826	36.60	34.61	113
2		3821	34.10		
3		3807	34.55		
4		3780	33.22		
1	400	3800	39.64	33.85	111
2		3832	33.03		
3		3852	32.94		
4		3764	29.79		
1	600	3846	27.75	27.21	89.18
2		3849	28.50		
3		3810	28.07		
4		3851	24.52		
1	800	3824	14.36	17.56	57.55
2		3860	19.29		
3		3804	18.92		
4		3818	16.42		

A.5 Tensile strength results of SFRC,SFRGC(Na) and SFRGC(K) at different elevated temperatures.

A.5.1 Tensile strength results of SFRC at different elevated temperatures.

Specimen No.	Temperature ⁰C	Tensile strength, MPa	Average tensile strength, MPa	Residual strength (%)
1	0	6.86	7.04	-
2		7.09		
3		7.17		
1	200	6.17	6.15	88.30
2		5.97		
3		6.29		
1	400	5.97	6.07	86.59
2		6.17		
3		6.12		
1	600	5.22	4.71	67.20
2		4.20		
3		4.74		
1	800	2.55	2.56	36.52
2		2.51		
3		2.62		

A.5.2 Tensile strength results of SFRGC(Na) at different elevated temperatures.

Specimen No.	Temperature ⁰C	Tensile strength, MPa	Average tensile strength, MPa	Residual strength (%)
1	0	6.86	6.47	-
2		6.26		
3		6.30		
1	200	6.07	6.73	104.02
2		7.36		
3		6.75		
1	400	6.07	6.29	97.21
2		6.51		
3		6.29		
1	600	4.83	4.91	75.89
2		4.99		
3		4.90		
1	800	1.91	1.91	29.52
2		1.90		
3		1.92		

A.5.3 Tensile strength results of SFRGC(K) at different elevated temperatures.

Specimen No.	Temperature ºC	Tensile strength, MPa	Average tensile strength, MPa	Residual strength (%)
1	0	3.15	3.10	-
2		2.96		
3		3.11		
1	200	5.01	4.51	145.48
2		4.00		
3		4.51		
1	400	5.33	5.18	167.09
2		5.04		
3		5.17		
1	600	4.00	3.63	116.13
2		3.18		
3		3.72		
1	800	2.14	2.22	71.93
2		2.21		
3		2.33		

APPENDIX B

Analytical data of elastic modulus test of concretes

B. 1 Test Data and Calculation of elastic modulus test of SFRC at ambient, 200, 400, 600, and 800^{0}C.

B.1.1 Elastic Modulus test results of SFRC at ambient temperature

Time	Absolute	Force	Stress	Strain
333.6	0.020559	0	0	0
333.7	0.020582	0.196	0.024955	2.21E-07
333.8	0.020654	0.392	0.049911	9.48E-07
333.9	0.020731	0.588	0.074866	1.72E-06
334	0.02075	0.784	0.099822	1.91E-06
334.1	0.020883	0.98	0.124777	3.24E-06
334.2	0.020946	1.176	0.149733	3.86E-06
334.3	0.020963	1.372	0.174688	4.04E-06
334.4	0.021018	1.568	0.199644	4.59E-06
334.5	0.021052	1.764	0.224599	4.93E-06
334.6	0.021113	1.96	0.249554	5.53E-06
334.7	0.021263	2.156	0.27451	7.03E-06
334.8	0.021277	2.352	0.299465	7.18E-06
334.9	0.021326	2.548	0.324421	7.67E-06
335	0.021404	2.744	0.349376	8.45E-06
335.1	0.021461	2.94	0.374332	9.01E-06
335.2	0.021446	3.136	0.399287	8.86E-06
335.3	0.021554	3.332	0.424242	9.94E-06
335.4	0.021632	3.528	0.449198	1.07E-05
335.5	0.021741	3.724	0.474153	1.18E-05
335.6	0.021796	3.92	0.499109	1.24E-05
335.7	0.021824	4.116	0.524064	1.26E-05
335.8	0.021845	4.312	0.54902	1.29E-05
335.9	0.02196	4.508	0.573975	1.4E-05
336	0.022008	4.704	0.598931	1.45E-05
336.1	0.022076	4.9	0.623886	1.52E-05
336.2	0.022102	5.096	0.648841	1.54E-05
336.3	0.02217	5.292	0.673797	1.61E-05
336.4	0.022248	5.488	0.698752	1.69E-05
336.5	0.022386	5.684	0.723708	1.83E-05
336.6	0.022393	5.88	0.748663	1.83E-05
336.7	0.022376	6.076	0.773619	1.82E-05
336.8	0.022494	6.272	0.798574	1.93E-05
336.9	0.022596	6.468	0.823529	2.04E-05
337	0.022536	6.664	0.848485	1.98E-05
337.1	0.022698	6.86	0.87344	2.14E-05
337.2	0.022811	7.056	0.898396	2.25E-05
337.3	0.022798	7.252	0.923351	2.24E-05
337.4	0.022865	7.448	0.948307	2.31E-05
337.5	0.022947	7.644	0.973262	2.39E-05
337.6	0.023015	7.84	0.998218	2.46E-05
337.7	0.023044	8.036	1.023173	2.48E-05
337.8	0.023149	8.232	1.048128	2.59E-05
337.9	0.023172	8.428	1.073084	2.61E-05
338	0.023258	8.624	1.098039	2.7E-05
338.1	0.023273	8.82	1.122995	2.71E-05
338.2	0.023323	9.016	1.14795	2.76E-05
338.3	0.023462	9.212	1.172906	2.9E-05
338.4	0.02354	9.408	1.197861	2.98E-05

338.5	0.023584	9.604	1.222816	3.02E-05
338.6	0.023673	9.8	1.247772	3.11E-05
338.7	0.023702	9.996	1.272727	3.14E-05
338.8	0.023694	10.192	1.297683	3.13E-05
338.9	0.02383	10.388	1.322638	3.27E-05
339	0.023916	10.584	1.347594	3.36E-05
339.1	0.023946	10.78	1.372549	3.39E-05
339.2	0.024042	10.976	1.397505	3.48E-05
339.3	0.024098	11.172	1.42246	3.54E-05
339.4	0.024046	11.368	1.447415	3.49E-05
339.5	0.024193	11.564	1.472371	3.63E-05
339.6	0.024203	11.76	1.497326	3.64E-05
339.7	0.024266	11.956	1.522282	3.71E-05
339.8	0.024423	12.152	1.547237	3.86E-05
339.9	0.02441	12.348	1.572193	3.85E-05
340	0.024457	12.544	1.597148	3.9E-05
340.1	0.024596	12.74	1.622103	4.04E-05
340.2	0.024603	12.936	1.647059	4.04E-05
340.3	0.024676	13.132	1.672014	4.12E-05
340.4	0.024732	13.328	1.69697	4.17E-05
340.5	0.024747	13.524	1.721925	4.19E-05
340.6	0.024819	13.72	1.746881	4.26E-05
340.7	0.024924	13.916	1.771836	4.37E-05
340.8	0.024982	14.112	1.796792	4.42E-05
340.9	0.025065	14.308	1.821747	4.51E-05
341	0.025114	14.504	1.846702	4.55E-05
341.1	0.025144	14.7	1.871658	4.59E-05
341.2	0.025211	14.896	1.896613	4.65E-05
341.3	0.025322	15.092	1.921569	4.76E-05
341.4	0.025321	15.288	1.946524	4.76E-05
341.5	0.025326	15.484	1.97148	4.77E-05
341.6	0.025419	15.68	1.996435	4.86E-05
341.7	0.025573	15.876	2.02139	5.01E-05
341.8	0.025622	16.072	2.046346	5.06E-05
341.9	0.025726	16.268	2.071301	5.17E-05
342	0.025777	16.464	2.096257	5.22E-05
342.1	0.025801	16.66	2.121212	5.24E-05
342.2	0.025821	16.856	2.146168	5.26E-05
342.3	0.025852	17.052	2.171123	5.29E-05
342.4	0.026027	17.248	2.196079	5.47E-05
342.5	0.026106	17.444	2.221034	5.55E-05
342.6	0.026063	17.64	2.245989	5.5E-05
342.7	0.026144	17.836	2.270945	5.58E-05
342.8	0.02624	18.032	2.2959	5.68E-05
342.9	0.026238	18.228	2.320856	5.68E-05
343	0.026343	18.424	2.345811	5.78E-05
343.1	0.026425	18.62	2.370767	5.87E-05
343.2	0.02652	18.816	2.395722	5.96E-05
343.3	0.026595	19.012	2.420677	6.04E-05
343.4	0.02665	19.208	2.445633	6.09E-05
343.5	0.026607	19.404	2.470588	6.05E-05
343.6	0.026691	19.6	2.495544	6.13E-05
343.7	0.026723	19.796	2.520499	6.16E-05
343.8	0.02675	19.992	2.545455	6.19E-05
343.9	0.026856	20.188	2.57041	6.3E-05

344	0.026932	20.384	2.595366	6.37E-05
344.1	0.027015	20.58	2.620321	6.46E-05
344.2	0.027174	20.776	2.645276	6.61E-05
344.3	0.027178	20.972	2.670232	6.62E-05
344.4	0.027177	21.168	2.695187	6.62E-05
344.5	0.027235	21.364	2.720143	6.68E-05
344.6	0.027287	21.56	2.745098	6.73E-05
344.7	0.027356	21.756	2.770054	6.8E-05
344.8	0.027573	21.952	2.795009	7.01E-05
344.9	0.02752	22.148	2.819964	6.96E-05
345	0.027481	22.344	2.84492	6.92E-05
345.1	0.027622	22.54	2.869875	7.06E-05
345.2	0.027776	22.736	2.894831	7.22E-05
345.3	0.027722	22.932	2.919786	7.16E-05
345.4	0.027841	23.128	2.944742	7.28E-05
345.5	0.027884	23.324	2.969697	7.33E-05
345.6	0.027991	23.52	2.994653	7.43E-05
345.7	0.028082	23.716	3.019608	7.52E-05
345.8	0.028041	23.912	3.044563	7.48E-05
345.9	0.028057	24.108	3.069519	7.5E-05
346	0.028184	24.304	3.094474	7.62E-05
346.1	0.028243	24.5	3.11943	7.68E-05
346.2	0.028302	24.696	3.144385	7.74E-05
346.3	0.028344	24.892	3.169341	7.78E-05
346.4	0.028439	25.088	3.194296	7.88E-05
346.5	0.028398	25.284	3.219251	7.84E-05
346.6	0.028553	25.48	3.244207	7.99E-05
346.7	0.028602	25.676	3.269162	8.04E-05
346.8	0.028715	25.872	3.294118	8.16E-05
346.9	0.028757	26.068	3.319073	8.2E-05
347	0.028716	26.264	3.344029	8.16E-05
347.1	0.028801	26.46	3.368984	8.24E-05
347.2	0.028927	26.656	3.39394	8.37E-05
347.3	0.02896	26.852	3.418895	8.4E-05
347.4	0.029025	27.048	3.44385	8.47E-05
347.5	0.029106	27.244	3.468806	8.55E-05
347.6	0.02913	27.44	3.493761	8.57E-05
347.7	0.029307	27.636	3.518717	8.75E-05
347.8	0.029322	27.832	3.543672	8.76E-05
347.9	0.029344	28.028	3.568628	8.78E-05
348	0.029429	28.224	3.593583	8.87E-05
348.1	0.02952	28.42	3.618538	8.96E-05
348.2	0.029498	28.616	3.643494	8.94E-05
348.3	0.029608	28.812	3.668449	9.05E-05
348.4	0.029653	29.008	3.693405	9.09E-05
348.5	0.029693	29.204	3.71836	9.13E-05
348.6	0.029805	29.4	3.743316	9.25E-05
348.7	0.029793	29.596	3.768271	9.23E-05
348.8	0.029865	29.792	3.793227	9.31E-05
348.9	0.03002	29.988	3.818182	9.46E-05
349	0.030004	30.184	3.843137	9.44E-05
349.1	0.030097	30.38	3.868093	9.54E-05
349.2	0.03016	30.576	3.893048	9.6E-05
349.3	0.030159	30.772	3.918004	9.6E-05
349.4	0.030333	30.968	3.942959	9.77E-05

349.5	0.030342	31.164	3.967915	9.78E-05
349.6	0.030382	31.36	3.99287	9.82E-05
349.7	0.03048	31.556	4.017826	9.92E-05
349.8	0.030473	31.752	4.042781	9.91E-05
349.9	0.030517	31.948	4.067736	9.96E-05
350	0.030691	32.144	4.092692	0.000101
350.1	0.030731	32.34	4.117647	0.000102
350.2	0.030733	32.536	4.142603	0.000102
350.3	0.030795	32.732	4.167558	0.000102
350.4	0.030865	32.928	4.192514	0.000103
350.5	0.030964	33.124	4.217469	0.000104
350.6	0.031057	33.32	4.242424	0.000105
350.7	0.031053	33.516	4.26738	0.000105
350.8	0.031121	33.712	4.292335	0.000106
350.9	0.031227	33.908	4.317291	0.000107
351	0.031228	34.104	4.342246	0.000107
351.1	0.031304	34.3	4.367202	0.000107
351.2	0.031416	34.496	4.392157	0.000109
351.3	0.031474	34.692	4.417113	0.000109
351.4	0.031505	34.888	4.442068	0.000109
351.5	0.031586	35.084	4.467023	0.00011
351.6	0.031616	35.28	4.491979	0.000111
351.7	0.031709	35.476	4.516934	0.000111
351.8	0.031734	35.672	4.54189	0.000112
351.9	0.031818	35.868	4.566845	0.000113
352	0.031866	36.064	4.591801	0.000113
352.1	0.031932	36.26	4.616756	0.000114
352.2	0.032047	36.456	4.641711	0.000115
352.3	0.032104	36.652	4.666667	0.000115
352.4	0.0321	36.848	4.691622	0.000115
352.5	0.03214	37.044	4.716578	0.000116
352.6	0.032217	37.24	4.741533	0.000117
352.7	0.032251	37.436	4.766489	0.000117
352.8	0.032364	37.632	4.791444	0.000118
352.9	0.032421	37.828	4.8164	0.000119
353	0.032468	38.024	4.841355	0.000119
353.1	0.032516	38.22	4.86631	0.00012
353.2	0.032566	38.416	4.891266	0.00012
353.3	0.032691	38.612	4.916221	0.000121
353.4	0.032779	38.808	4.941177	0.000122
353.5	0.032753	39.004	4.966132	0.000122
353.6	0.032841	39.2	4.991088	0.000123
353.7	0.032916	39.396	5.016043	0.000124
353.8	0.032904	39.592	5.040998	0.000123
353.9	0.033079	39.788	5.065954	0.000125
354	0.033103	39.984	5.090909	0.000125
354.1	0.033139	40.18	5.115865	0.000126
354.2	0.033199	40.376	5.14082	0.000126
354.3	0.033218	40.572	5.165776	0.000127
354.4	0.033328	40.768	5.190731	0.000128
354.5	0.033457	40.964	5.215687	0.000129
354.6	0.033452	41.16	5.240642	0.000129
354.7	0.033534	41.356	5.265597	0.00013
354.8	0.03363	41.552	5.290553	0.000131
354.9	0.033611	41.748	5.315508	0.000131

355	0.033731	41.944	5.340464	0.000132
355.1	0.033746	42.14	5.365419	0.000132
355.2	0.033814	42.336	5.390375	0.000133
355.3	0.033848	42.532	5.41533	0.000133
355.4	0.033906	42.728	5.440285	0.000133
355.5	0.034003	42.924	5.465241	0.000134
355.6	0.034089	43.12	5.490196	0.000135
355.7	0.034102	43.316	5.515152	0.000135
355.8	0.03417	43.512	5.540107	0.000136
355.9	0.034235	43.708	5.565063	0.000137
356	0.034274	43.904	5.590018	0.000137
356.1	0.034374	44.1	5.614974	0.000138
356.2	0.034388	44.296	5.639929	0.000138
356.3	0.034443	44.492	5.664884	0.000139
356.4	0.034566	44.688	5.68984	0.00014
356.5	0.03455	44.884	5.714795	0.00014
356.6	0.034702	45.08	5.739751	0.000141
356.7	0.034754	45.276	5.764706	0.000142
356.8	0.034764	45.472	5.789662	0.000142
356.9	0.034863	45.668	5.814617	0.000143
357	0.034912	45.864	5.839572	0.000144
357.1	0.034883	46.06	5.864528	0.000143
357.2	0.035086	46.256	5.889483	0.000145
357.3	0.035105	46.452	5.914439	0.000145
357.4	0.035143	46.648	5.939394	0.000146
357.5	0.035238	46.844	5.96435	0.000147
357.6	0.035237	47.04	5.989305	0.000147
357.7	0.035327	47.236	6.014261	0.000148
357.8	0.035442	47.432	6.039216	0.000149
357.9	0.035487	47.628	6.064171	0.000149
358	0.035538	47.824	6.089127	0.00015
358.1	0.035581	48.02	6.114082	0.00015
358.2	0.035634	48.216	6.139038	0.000151
358.3	0.035724	48.412	6.163993	0.000152
358.4	0.035734	48.608	6.188949	0.000152
358.5	0.035844	48.804	6.213904	0.000153
358.6	0.0359	49	6.238859	0.000153
358.7	0.035858	49.196	6.263815	0.000153
358.8	0.036065	49.392	6.28877	0.000155
358.9	0.036061	49.588	6.313726	0.000155
359	0.03611	49.784	6.338681	0.000156
359.1	0.036188	49.98	6.363637	0.000156
359.2	0.03625	50.176	6.388592	0.000157
359.3	0.036372	50.372	6.413548	0.000158
359.4	0.036359	50.568	6.438503	0.000158
359.5	0.036434	50.764	6.463458	0.000159
359.6	0.036495	50.96	6.488414	0.000159
359.7	0.036483	51.156	6.513369	0.000159
359.8	0.036625	51.352	6.538325	0.000161
359.9	0.036711	51.548	6.56328	0.000162
360	0.036721	51.744	6.588236	0.000162
360.1	0.036841	51.94	6.613191	0.000163
360.2	0.036881	52.136	6.638146	0.000163
360.3	0.036935	52.332	6.663102	0.000164
360.4	0.037016	52.528	6.688057	0.000165

360.5	0.037064	52.724	6.713013	0.000165
360.6	0.037171	52.92	6.737968	0.000166
360.7	0.037173	53.116	6.762924	0.000166
360.8	0.037194	53.312	6.787879	0.000166
360.9	0.037383	53.508	6.812835	0.000168
361	0.037375	53.704	6.83779	0.000168
361.1	0.037415	53.9	6.862745	0.000169
361.2	0.037498	54.096	6.887701	0.000169
361.3	0.037515	54.292	6.912656	0.00017
361.4	0.037601	54.488	6.937612	0.00017
361.5	0.037656	54.684	6.962567	0.000171
361.6	0.037742	54.88	6.987523	0.000172
361.7	0.037781	55.076	7.012478	0.000172
361.8	0.037787	55.272	7.037433	0.000172
361.9	0.037894	55.468	7.062389	0.000173
362	0.037938	55.664	7.087344	0.000174
362.1	0.038008	55.86	7.1123	0.000174
362.2	0.03811	56.056	7.137255	0.000176
362.3	0.038165	56.252	7.162211	0.000176
362.4	0.038171	56.448	7.187166	0.000176
362.5	0.038339	56.644	7.212122	0.000178
362.6	0.038312	56.84	7.237077	0.000178
362.7	0.038365	57.036	7.262032	0.000178
362.8	0.038456	57.232	7.286988	0.000179
362.9	0.038476	57.428	7.311943	0.000179
363	0.038613	57.624	7.336899	0.000181
363.1	0.038685	57.82	7.361854	0.000181
363.2	0.038761	58.016	7.38681	0.000182
363.3	0.038749	58.212	7.411765	0.000182
363.4	0.038767	58.408	7.43672	0.000182
363.5	0.038905	58.604	7.461676	0.000183
363.6	0.03895	58.8	7.486631	0.000184
363.7	0.038993	58.996	7.511587	0.000184
363.8	0.039045	59.192	7.536542	0.000185
363.9	0.039127	59.388	7.561498	0.000186
364	0.039188	59.584	7.586453	0.000186
364.1	0.039245	59.78	7.611409	0.000187
364.2	0.039283	59.976	7.636364	0.000187
364.3	0.039353	60.172	7.661319	0.000188
364.4	0.039426	60.368	7.686275	0.000189
364.5	0.039443	60.564	7.71123	0.000189
364.6	0.039582	60.76	7.736186	0.00019
364.7	0.039611	60.956	7.761141	0.000191
364.8	0.039657	61.152	7.786097	0.000191
364.9	0.039776	61.348	7.811052	0.000192
365	0.039753	61.544	7.836008	0.000192
365.1	0.039849	61.74	7.860963	0.000193
365.2	0.039889	61.936	7.885918	0.000193
365.3	0.039952	62.132	7.910874	0.000194
365.4	0.040045	62.328	7.935829	0.000195
365.5	0.04009	62.524	7.960785	0.000195
365.6	0.040134	62.72	7.98574	0.000196
365.7	0.040255	62.916	8.010696	0.000197
365.8	0.040248	63.112	8.035651	0.000197
365.9	0.04032	63.308	8.060606	0.000198

366	0.040381	63.504	8.085562	0.000198
366.1	0.040406	63.7	8.110517	0.000198
366.2	0.040575	63.896	8.135473	0.0002
366.3	0.040606	64.092	8.160428	0.0002
366.4	0.04061	64.288	8.185384	0.000201
366.5	0.040669	64.484	8.210339	0.000201
366.6	0.040723	64.68	8.235295	0.000202
366.7	0.04084	64.876	8.26025	0.000203
366.8	0.040942	65.072	8.285205	0.000204
366.9	0.040931	65.268	8.310161	0.000204
367	0.04098	65.464	8.335116	0.000204
367.1	0.04106	65.66	8.360072	0.000205
367.2	0.041058	65.856	8.385027	0.000205
367.3	0.041211	66.052	8.409983	0.000207
367.4	0.041227	66.248	8.434938	0.000207
367.5	0.041286	66.444	8.459893	0.000207
367.6	0.04135	66.64	8.484849	0.000208
367.7	0.041335	66.836	8.509804	0.000208
367.8	0.041477	67.032	8.53476	0.000209
367.9	0.041543	67.228	8.559715	0.00021
368	0.041613	67.424	8.584671	0.000211
368.1	0.04166	67.62	8.609626	0.000211
368.2	0.041661	67.816	8.634582	0.000211
368.3	0.041768	68.012	8.659537	0.000212
368.4	0.041864	68.208	8.684492	0.000213
368.5	0.04185	68.404	8.709448	0.000213
368.6	0.041954	68.6	8.734403	0.000214
368.7	0.042027	68.796	8.759359	0.000215
368.8	0.042061	68.992	8.784314	0.000215
368.9	0.0422	69.188	8.80927	0.000216
369	0.042224	69.384	8.834225	0.000217
369.1	0.042304	69.58	8.85918	0.000217
369.2	0.042357	69.776	8.884136	0.000218
369.3	0.042358	69.972	8.909091	0.000218
369.4	0.042485	70.168	8.934047	0.000219
369.5	0.042566	70.364	8.959002	0.00022
369.6	0.042569	70.56	8.983958	0.00022
369.7	0.042628	70.756	9.008913	0.000221
369.8	0.042624	70.952	9.033869	0.000221
369.9	0.04278	71.148	9.058824	0.000222
370	0.042846	71.344	9.083779	0.000223
370.1	0.042897	71.54	9.108735	0.000223
370.2	0.042929	71.736	9.13369	0.000224
370.3	0.042981	71.932	9.158646	0.000224
370.4	0.04298	72.128	9.183601	0.000224
370.5	0.043125	72.324	9.208557	0.000226
370.6	0.043144	72.52	9.233512	0.000226
370.7	0.043216	72.716	9.258467	0.000227
370.8	0.043306	72.912	9.283423	0.000227
370.9	0.04332	73.108	9.308378	0.000228
371	0.043426	73.304	9.333334	0.000229
371.1	0.043453	73.5	9.358289	0.000229
371.2	0.043553	73.696	9.383245	0.00023
371.3	0.043598	73.892	9.4082	0.00023
371.4	0.043591	74.088	9.433156	0.00023

371.5	0.043715	74.284	9.458111	0.000232
371.6	0.043765	74.48	9.483066	0.000232
371.7	0.043785	74.676	9.508022	0.000232
371.8	0.043881	74.872	9.532977	0.000233
371.9	0.043889	75.068	9.557933	0.000233
372	0.043986	75.264	9.582888	0.000234
372.1	0.044086	75.46	9.607844	0.000235
372.2	0.044129	75.656	9.632799	0.000236
372.3	0.044212	75.852	9.657754	0.000237
372.4	0.044253	76.048	9.68271	0.000237

B.1.2 Elastic Modulus test results of SFRC at 200⁰C temperature.

Time	Absolute	Force	Stress	Strain
234.4	0.019956	0	0	0
234.5	0.020007	0.196	0.024955	5.11E-07
234.6	0.020095	0.392	0.049911	1.39E-06
234.7	0.020162	0.588	0.074866	2.06E-06
234.8	0.020245	0.784	0.099822	2.89E-06
234.9	0.020365	0.98	0.124777	4.09E-06
235	0.020451	1.176	0.149733	4.95E-06
235.1	0.020501	1.372	0.174688	5.45E-06
235.2	0.020591	1.568	0.199644	6.35E-06
235.3	0.020686	1.764	0.224599	7.3E-06
235.4	0.020743	1.96	0.249554	7.87E-06
235.5	0.020822	2.156	0.27451	8.66E-06
235.6	0.020927	2.352	0.299465	9.71E-06
235.7	0.021026	2.548	0.324421	1.07E-05
235.8	0.021083	2.744	0.349376	1.13E-05
235.9	0.021155	2.94	0.374332	1.2E-05
236	0.021306	3.136	0.399287	1.35E-05
236.1	0.021387	3.332	0.424242	1.43E-05
236.2	0.021466	3.528	0.449198	1.51E-05
236.3	0.02157	3.724	0.474153	1.61E-05
236.4	0.021655	3.92	0.499109	1.7E-05
236.5	0.021758	4.116	0.524064	1.8E-05
236.6	0.021814	4.312	0.54902	1.86E-05
236.7	0.021895	4.508	0.573975	1.94E-05
236.8	0.021979	4.704	0.598931	2.02E-05
236.9	0.022065	4.9	0.623886	2.11E-05
237	0.02216	5.096	0.648841	2.2E-05
237.1	0.022243	5.292	0.673797	2.29E-05
237.2	0.022344	5.488	0.698752	2.39E-05
237.3	0.022433	5.684	0.723708	2.48E-05
237.4	0.022508	5.88	0.748663	2.55E-05
237.5	0.022584	6.076	0.773619	2.63E-05
237.6	0.022681	6.272	0.798574	2.72E-05
237.7	0.022764	6.468	0.823529	2.81E-05
237.8	0.022807	6.664	0.848485	2.85E-05
237.9	0.022872	6.86	0.87344	2.92E-05

238	0.023009	7.056	0.898396	3.05E-05
238.1	0.023087	7.252	0.923351	3.13E-05
238.2	0.023139	7.448	0.948307	3.18E-05
238.3	0.023214	7.644	0.973262	3.26E-05
238.4	0.023327	7.84	0.998218	3.37E-05
238.5	0.023437	8.036	1.023173	3.48E-05
238.6	0.023498	8.232	1.048128	3.54E-05
238.7	0.023579	8.428	1.073084	3.62E-05
238.8	0.023652	8.624	1.098039	3.7E-05
238.9	0.023752	8.82	1.122995	3.8E-05
239	0.023852	9.016	1.14795	3.9E-05
239.1	0.023922	9.212	1.172906	3.97E-05
239.2	0.023987	9.408	1.197861	4.03E-05
239.3	0.024092	9.604	1.222816	4.14E-05
239.4	0.024177	9.8	1.247772	4.22E-05
239.5	0.024219	9.996	1.272727	4.26E-05
239.6	0.024317	10.192	1.297683	4.36E-05
239.7	0.024411	10.388	1.322638	4.46E-05
239.8	0.024504	10.584	1.347594	4.55E-05
239.9	0.024588	10.78	1.372549	4.63E-05
240	0.024679	10.976	1.397505	4.72E-05
240.1	0.024782	11.172	1.42246	4.83E-05
240.2	0.024879	11.368	1.447415	4.92E-05
240.3	0.024937	11.564	1.472371	4.98E-05
240.4	0.025019	11.76	1.497326	5.06E-05
240.5	0.025136	11.956	1.522282	5.18E-05
240.6	0.025227	12.152	1.547237	5.27E-05
240.7	0.025274	12.348	1.572193	5.32E-05
240.8	0.025349	12.544	1.597148	5.39E-05
240.9	0.025448	12.74	1.622103	5.49E-05
241	0.025532	12.936	1.647059	5.58E-05
241.1	0.025606	13.132	1.672014	5.65E-05
241.2	0.025702	13.328	1.69697	5.75E-05
241.3	0.025749	13.524	1.721925	5.79E-05
241.4	0.025857	13.72	1.746881	5.9E-05
241.5	0.025957	13.916	1.771836	6E-05
241.6	0.026022	14.112	1.796792	6.07E-05
241.7	0.026089	14.308	1.821747	6.13E-05
241.8	0.026198	14.504	1.846702	6.24E-05
241.9	0.026258	14.7	1.871658	6.3E-05
242	0.026344	14.896	1.896613	6.39E-05
242.1	0.02641	15.092	1.921569	6.45E-05
242.2	0.026455	15.288	1.946524	6.5E-05
242.3	0.026537	15.484	1.97148	6.58E-05
242.4	0.026654	15.68	1.996435	6.7E-05
242.5	0.02674	15.876	2.02139	6.78E-05
242.6	0.026824	16.072	2.046346	6.87E-05
242.7	0.026925	16.268	2.071301	6.97E-05
242.8	0.026989	16.464	2.096257	7.03E-05
242.9	0.027037	16.66	2.121212	7.08E-05
243	0.027155	16.856	2.146168	7.2E-05
243.1	0.027255	17.052	2.171123	7.3E-05
243.2	0.027326	17.248	2.196079	7.37E-05
243.3	0.027388	17.444	2.221034	7.43E-05
243.4	0.027448	17.64	2.245989	7.49E-05

243.5	0.027546	17.836	2.270945	7.59E-05
243.6	0.027634	18.032	2.2959	7.68E-05
243.7	0.02771	18.228	2.320856	7.75E-05
243.8	0.027801	18.424	2.345811	7.84E-05
243.9	0.027866	18.62	2.370767	7.91E-05
244	0.027948	18.816	2.395722	7.99E-05
244.1	0.028047	19.012	2.420677	8.09E-05
244.2	0.02818	19.208	2.445633	8.22E-05
244.3	0.028243	19.404	2.470588	8.29E-05
244.4	0.028316	19.6	2.495544	8.36E-05
244.5	0.028385	19.796	2.520499	8.43E-05
244.6	0.028439	19.992	2.545455	8.48E-05
244.7	0.028534	20.188	2.57041	8.58E-05
244.8	0.028606	20.384	2.595366	8.65E-05
244.9	0.028686	20.58	2.620321	8.73E-05
245	0.028782	20.776	2.645276	8.83E-05
245.1	0.028873	20.972	2.670232	8.92E-05
245.2	0.028959	21.168	2.695187	9E-05
245.3	0.029012	21.364	2.720143	9.06E-05
245.4	0.029119	21.56	2.745098	9.16E-05
245.5	0.029197	21.756	2.770054	9.24E-05
245.6	0.029271	21.952	2.795009	9.31E-05
245.7	0.029342	22.148	2.819964	9.39E-05
245.8	0.029424	22.344	2.84492	9.47E-05
245.9	0.029507	22.54	2.869875	9.55E-05
246	0.029598	22.736	2.894831	9.64E-05
246.1	0.029665	22.932	2.919786	9.71E-05
246.2	0.029734	23.128	2.944742	9.78E-05
246.3	0.029856	23.324	2.969697	9.9E-05
246.4	0.029938	23.52	2.994653	9.98E-05
246.5	0.030004	23.716	3.019608	0.0001
246.6	0.030112	23.912	3.044563	0.000102
246.7	0.030166	24.108	3.069519	0.000102
246.8	0.030244	24.304	3.094474	0.000103
246.9	0.030312	24.5	3.11943	0.000104
247	0.03044	24.696	3.144385	0.000105
247.1	0.030513	24.892	3.169341	0.000106
247.2	0.030556	25.088	3.194296	0.000106
247.3	0.030623	25.284	3.219251	0.000107
247.4	0.03071	25.48	3.244207	0.000108
247.5	0.030806	25.676	3.269162	0.000109
247.6	0.030898	25.872	3.294118	0.000109
247.7	0.030957	26.068	3.319073	0.00011
247.8	0.031019	26.264	3.344029	0.000111
247.9	0.031134	26.46	3.368984	0.000112
248	0.031218	26.656	3.39394	0.000113
248.1	0.031271	26.852	3.418895	0.000113
248.2	0.031387	27.048	3.44385	0.000114
248.3	0.031476	27.244	3.468806	0.000115
248.4	0.03154	27.44	3.493761	0.000116
248.5	0.031606	27.636	3.518717	0.000116
248.6	0.031706	27.832	3.543672	0.000117
248.7	0.031805	28.028	3.568628	0.000118
248.8	0.031829	28.224	3.593583	0.000119
248.9	0.031963	28.42	3.618538	0.00012

249	0.032035	28.616	3.643494	0.000121
249.1	0.032115	28.812	3.668449	0.000122
249.2	0.032188	29.008	3.693405	0.000122
249.3	0.03225	29.204	3.71836	0.000123
249.4	0.032362	29.4	3.743316	0.000124
249.5	0.032428	29.596	3.768271	0.000125
249.6	0.032518	29.792	3.793227	0.000126
249.7	0.032593	29.988	3.818182	0.000126
249.8	0.032685	30.184	3.843137	0.000127
249.9	0.032739	30.38	3.868093	0.000128
250	0.032854	30.576	3.893048	0.000129
250.1	0.032889	30.772	3.918004	0.000129
250.2	0.032984	30.968	3.942959	0.00013
250.3	0.033122	31.164	3.967915	0.000132
250.4	0.033192	31.36	3.99287	0.000132
250.5	0.033232	31.556	4.017826	0.000133
250.6	0.03327	31.752	4.042781	0.000133
250.7	0.03341	31.948	4.067736	0.000135
250.8	0.033489	32.144	4.092692	0.000135
250.9	0.033521	32.34	4.117647	0.000136
251	0.033628	32.536	4.142603	0.000137
251.1	0.03365	32.732	4.167558	0.000137
251.2	0.033691	32.928	4.192514	0.000137
251.3	0.033819	33.124	4.217469	0.000139
251.4	0.033996	33.32	4.242424	0.00014
251.5	0.034015	33.516	4.26738	0.000141
251.6	0.034091	33.712	4.292335	0.000141
251.7	0.034149	33.908	4.317291	0.000142
251.8	0.034143	34.104	4.342246	0.000142
251.9	0.034258	34.3	4.367202	0.000143
252	0.034447	34.496	4.392157	0.000145
252.1	0.034499	34.692	4.417113	0.000145
252.2	0.034507	34.888	4.442068	0.000146
252.3	0.034598	35.084	4.467023	0.000146
252.4	0.034771	35.28	4.491979	0.000148
252.5	0.034814	35.476	4.516934	0.000149
252.6	0.034834	35.672	4.54189	0.000149
252.7	0.034942	35.868	4.566845	0.00015
252.8	0.035062	36.064	4.591801	0.000151
252.9	0.035052	36.26	4.616756	0.000151
253	0.035113	36.456	4.641711	0.000152
253.1	0.035189	36.652	4.666667	0.000152
253.2	0.035322	36.848	4.691622	0.000154
253.3	0.035482	37.044	4.716578	0.000155
253.4	0.035498	37.24	4.741533	0.000155
253.5	0.035497	37.436	4.766489	0.000155
253.6	0.035595	37.632	4.791444	0.000156
253.7	0.035693	37.828	4.8164	0.000157
253.8	0.035843	38.024	4.841355	0.000159
253.9	0.035883	38.22	4.86631	0.000159
254	0.035841	38.416	4.891266	0.000159
254.1	0.035972	38.612	4.916221	0.00016
254.2	0.036056	38.808	4.941177	0.000161
254.3	0.03615	39.004	4.966132	0.000162
254.4	0.036219	39.2	4.991088	0.000163

254.5	0.036239	39.396	5.016043	0.000163
254.6	0.036334	39.592	5.040998	0.000164
254.7	0.036404	39.788	5.065954	0.000164
254.8	0.036483	39.984	5.090909	0.000165
254.9	0.036572	40.18	5.115865	0.000166
255	0.03664	40.376	5.14082	0.000167
255.1	0.036735	40.572	5.165776	0.000168
255.2	0.036788	40.768	5.190731	0.000168
255.3	0.036866	40.964	5.215687	0.000169
255.4	0.036974	41.16	5.240642	0.00017
255.5	0.037102	41.356	5.265597	0.000171
255.6	0.037114	41.552	5.290553	0.000172
255.7	0.037161	41.748	5.315508	0.000172
255.8	0.037283	41.944	5.340464	0.000173
255.9	0.037374	42.14	5.365419	0.000174
256	0.037406	42.336	5.390375	0.000174
256.1	0.037523	42.532	5.41533	0.000176
256.2	0.037617	42.728	5.440285	0.000177
256.3	0.037702	42.924	5.465241	0.000177
256.4	0.037729	43.12	5.490196	0.000178
256.5	0.037798	43.316	5.515152	0.000178
256.6	0.037906	43.512	5.540107	0.00018
256.7	0.037953	43.708	5.565063	0.00018
256.8	0.038032	43.904	5.590018	0.000181
256.9	0.038156	44.1	5.614974	0.000182
257	0.038198	44.296	5.639929	0.000182
257.1	0.038247	44.492	5.664884	0.000183
257.2	0.038352	44.688	5.68984	0.000184
257.3	0.038415	44.884	5.714795	0.000185
257.4	0.038501	45.08	5.739751	0.000185
257.5	0.038649	45.276	5.764706	0.000187
257.6	0.038684	45.472	5.789662	0.000187
257.7	0.038716	45.668	5.814617	0.000188
257.8	0.038855	45.864	5.839572	0.000189
257.9	0.038902	46.06	5.864528	0.000189
258	0.038974	46.256	5.889483	0.00019
258.1	0.039064	46.452	5.914439	0.000191
258.2	0.039159	46.648	5.939394	0.000192
258.3	0.039229	46.844	5.96435	0.000193
258.4	0.039267	47.04	5.989305	0.000193
258.5	0.039366	47.236	6.014261	0.000194
258.6	0.039429	47.432	6.039216	0.000195
258.7	0.039505	47.628	6.064171	0.000195
258.8	0.03961	47.824	6.089127	0.000197
258.9	0.039698	48.02	6.114082	0.000197
259	0.03975	48.216	6.139038	0.000198
259.1	0.039793	48.412	6.163993	0.000198
259.2	0.039904	48.608	6.188949	0.000199
259.3	0.039952	48.804	6.213904	0.0002
259.4	0.04005	49	6.238859	0.000201
259.5	0.04013	49.196	6.263815	0.000202
259.6	0.040186	49.392	6.28877	0.000202
259.7	0.040263	49.588	6.313726	0.000203
259.8	0.040339	49.784	6.338681	0.000204
259.9	0.040426	49.98	6.363637	0.000205

260	0.040485	50.176	6.388592	0.000205
260.1	0.040555	50.372	6.413548	0.000206
260.2	0.040629	50.568	6.438503	0.000207
260.3	0.040689	50.764	6.463458	0.000207
260.4	0.040792	50.96	6.488414	0.000208
260.5	0.040876	51.156	6.513369	0.000209
260.6	0.040914	51.352	6.538325	0.00021
260.7	0.040991	51.548	6.56328	0.00021
260.8	0.041103	51.744	6.588236	0.000211
260.9	0.041161	51.94	6.613191	0.000212
261	0.041236	52.136	6.638146	0.000213
261.1	0.041338	52.332	6.663102	0.000214
261.2	0.041433	52.528	6.688057	0.000215
261.3	0.041496	52.724	6.713013	0.000215
261.4	0.041567	52.92	6.737968	0.000216
261.5	0.041645	53.116	6.762924	0.000217
261.6	0.041714	53.312	6.787879	0.000218
261.7	0.041774	53.508	6.812835	0.000218
261.8	0.041862	53.704	6.83779	0.000219
261.9	0.041938	53.9	6.862745	0.00022
262	0.042031	54.096	6.887701	0.000221
262.1	0.04212	54.292	6.912656	0.000222
262.2	0.042165	54.488	6.937612	0.000222
262.3	0.042229	54.684	6.962567	0.000223
262.4	0.04232	54.88	6.987523	0.000224
262.5	0.042382	55.076	7.012478	0.000224
262.6	0.042458	55.272	7.037433	0.000225
262.7	0.042514	55.468	7.062389	0.000226
262.8	0.042601	55.664	7.087344	0.000226
262.9	0.042674	55.86	7.1123	0.000227
263	0.042757	56.056	7.137255	0.000228
263.1	0.04282	56.252	7.162211	0.000229
263.2	0.042891	56.448	7.187166	0.000229
263.3	0.042964	56.644	7.212122	0.00023
263.4	0.043049	56.84	7.237077	0.000231
263.5	0.0431	57.036	7.262032	0.000231
263.6	0.043194	57.232	7.286988	0.000232
263.7	0.043298	57.428	7.311943	0.000233
263.8	0.043337	57.624	7.336899	0.000234
263.9	0.04337	57.82	7.361854	0.000234
264	0.043484	58.016	7.38681	0.000235
264.1	0.04357	58.212	7.411765	0.000236
264.2	0.043641	58.408	7.43672	0.000237
264.3	0.043694	58.604	7.461676	0.000237
264.4	0.043755	58.8	7.486631	0.000238
264.5	0.04384	58.996	7.511587	0.000239
264.6	0.043922	59.192	7.536542	0.00024
264.7	0.044026	59.388	7.561498	0.000241
264.8	0.04411	59.584	7.586453	0.000242
264.9	0.044152	59.78	7.611409	0.000242
265	0.04424	59.976	7.636364	0.000243
265.1	0.044296	60.172	7.661319	0.000243
265.2	0.044353	60.368	7.686275	0.000244
265.3	0.044453	60.564	7.71123	0.000245
265.4	0.044529	60.76	7.736186	0.000246

265.5	0.044581	60.956	7.761141	0.000246
265.6	0.044646	61.152	7.786097	0.000247
265.7	0.044733	61.348	7.811052	0.000248
265.8	0.044785	61.544	7.836008	0.000248
265.9	0.044857	61.74	7.860963	0.000249
266	0.044934	61.936	7.885918	0.00025
266.1	0.045005	62.132	7.910874	0.00025
266.2	0.04507	62.328	7.935829	0.000251
266.3	0.045133	62.524	7.960785	0.000252
266.4	0.045245	62.72	7.98574	0.000253
266.5	0.045312	62.916	8.010696	0.000254
266.6	0.04539	63.112	8.035651	0.000254
266.7	0.045482	63.308	8.060606	0.000255
266.8	0.045528	63.504	8.085562	0.000256
266.9	0.045581	63.7	8.110517	0.000256
267	0.04568	63.896	8.135473	0.000257
267.1	0.045758	64.092	8.160428	0.000258
267.2	0.045815	64.288	8.185384	0.000259
267.3	0.045868	64.484	8.210339	0.000259
267.4	0.045955	64.68	8.235295	0.00026
267.5	0.045999	64.876	8.26025	0.00026
267.6	0.046068	65.072	8.285205	0.000261
267.7	0.046181	65.268	8.310161	0.000262
267.8	0.046231	65.464	8.335116	0.000263
267.9	0.046284	65.66	8.360072	0.000263
268	0.046384	65.856	8.385027	0.000264
268.1	0.046474	66.052	8.409983	0.000265
268.2	0.046546	66.248	8.434938	0.000266
268.3	0.046586	66.444	8.459893	0.000266
268.4	0.046683	66.64	8.484849	0.000267
268.5	0.046782	66.836	8.509804	0.000268
268.6	0.046835	67.032	8.53476	0.000269
268.7	0.046878	67.228	8.559715	0.000269
268.8	0.046957	67.424	8.584671	0.00027
268.9	0.047035	67.62	8.609626	0.000271
269	0.047102	67.816	8.634582	0.000271
269.1	0.047179	68.012	8.659537	0.000272
269.2	0.047256	68.208	8.684492	0.000273
269.3	0.04736	68.404	8.709448	0.000274
269.4	0.047412	68.6	8.734403	0.000275

B.1.3 Elastic Modulus test results of SFRC at 400ºC temperature.

Time	Absolute	force	stress	Strain
124.5	0.097943	0	0	0
124.6	0.098091	0.196	0.024955	1.48E-06
124.7	0.098216	0.392	0.049911	2.73E-06
124.8	0.09835	0.588	0.074866	4.07E-06
124.9	0.098485	0.784	0.099822	5.42E-06
125	0.098694	0.98	0.124777	7.51E-06

125.1	0.098831	1.176	0.149733	8.88E-06
125.2	0.098944	1.372	0.174688	1E-05
125.3	0.09915	1.568	0.199644	1.21E-05
125.4	0.099283	1.764	0.224599	1.34E-05
125.5	0.099451	1.96	0.249554	1.51E-05
125.6	0.099617	2.156	0.27451	1.67E-05
125.7	0.099774	2.352	0.299465	1.83E-05
125.8	0.099952	2.548	0.324421	2.01E-05
125.9	0.100082	2.744	0.349376	2.14E-05
126	0.100218	2.94	0.374332	2.28E-05
126.1	0.100371	3.136	0.399287	2.43E-05
126.2	0.100555	3.332	0.424242	2.61E-05
126.3	0.100711	3.528	0.449198	2.77E-05
126.4	0.100862	3.724	0.474153	2.92E-05
126.5	0.101053	3.92	0.499109	3.11E-05
126.6	0.101212	4.116	0.524064	3.27E-05
126.7	0.101346	4.312	0.54902	3.4E-05
126.8	0.10153	4.508	0.573975	3.59E-05
126.9	0.101692	4.704	0.598931	3.75E-05
127	0.101812	4.9	0.623886	3.87E-05
127.1	0.101983	5.096	0.648841	4.04E-05
127.2	0.10214	5.292	0.673797	4.2E-05
127.3	0.102291	5.488	0.698752	4.35E-05
127.4	0.10243	5.684	0.723708	4.49E-05
127.5	0.102591	5.88	0.748663	4.65E-05
127.6	0.102767	6.076	0.773619	4.82E-05
127.7	0.102932	6.272	0.798574	4.99E-05
127.8	0.103065	6.468	0.823529	5.12E-05
127.9	0.103233	6.664	0.848485	5.29E-05
128	0.103396	6.86	0.87344	5.45E-05
128.1	0.103536	7.056	0.898396	5.59E-05
128.2	0.103717	7.252	0.923351	5.77E-05
128.3	0.103855	7.448	0.948307	5.91E-05
128.4	0.104019	7.644	0.973262	6.08E-05
128.5	0.104167	7.84	0.998218	6.22E-05
128.6	0.104315	8.036	1.023173	6.37E-05
128.7	0.1045	8.232	1.048128	6.56E-05
128.8	0.104625	8.428	1.073084	6.68E-05
128.9	0.104795	8.624	1.098039	6.85E-05
129	0.104958	8.82	1.122995	7.01E-05
129.1	0.105068	9.016	1.14795	7.13E-05
129.2	0.10524	9.212	1.172906	7.3E-05
129.3	0.10538	9.408	1.197861	7.44E-05
129.4	0.105504	9.604	1.222816	7.56E-05
129.5	0.105669	9.8	1.247772	7.73E-05
129.6	0.10584	9.996	1.272727	7.9E-05
129.7	0.105988	10.192	1.297683	8.04E-05
129.8	0.106125	10.388	1.322638	8.18E-05
129.9	0.106318	10.584	1.347594	8.38E-05
130	0.106487	10.78	1.372549	8.54E-05
130.1	0.106645	10.976	1.397505	8.7E-05
130.2	0.106807	11.172	1.42246	8.86E-05
130.3	0.106948	11.368	1.447415	9.01E-05
130.4	0.107105	11.564	1.472371	9.16E-05
130.5	0.107306	11.76	1.497326	9.36E-05

130.6	0.107433	11.956	1.522282	9.49E-05
130.7	0.107555	12.152	1.547237	9.61E-05
130.8	0.107724	12.348	1.572193	9.78E-05
130.9	0.107873	12.544	1.597148	9.93E-05
131	0.108054	12.74	1.622103	0.000101
131.1	0.108237	12.936	1.647059	0.000103
131.2	0.108362	13.132	1.672014	0.000104
131.3	0.108482	13.328	1.69697	0.000105
131.4	0.108636	13.524	1.721925	0.000107
131.5	0.108798	13.72	1.746881	0.000109
131.6	0.108911	13.916	1.771836	0.00011
131.7	0.109026	14.112	1.796792	0.000111
131.8	0.109199	14.308	1.821747	0.000113
131.9	0.10936	14.504	1.846702	0.000114
132	0.109491	14.7	1.871658	0.000115
132.1	0.109634	14.896	1.896613	0.000117
132.2	0.109819	15.092	1.921569	0.000119
132.3	0.109939	15.288	1.946524	0.00012
132.4	0.110087	15.484	1.97148	0.000121
132.5	0.110251	15.68	1.996435	0.000123
132.6	0.11039	15.876	2.02139	0.000124
132.7	0.110569	16.072	2.046346	0.000126
132.8	0.110723	16.268	2.071301	0.000128
132.9	0.110871	16.464	2.096257	0.000129
133	0.111014	16.66	2.121212	0.000131
133.1	0.111141	16.856	2.146168	0.000132
133.2	0.111307	17.052	2.171123	0.000134
133.3	0.11147	17.248	2.196079	0.000135
133.4	0.111647	17.444	2.221034	0.000137
133.5	0.111793	17.64	2.245989	0.000138
133.6	0.111944	17.836	2.270945	0.00014
133.7	0.112051	18.032	2.2959	0.000141
133.8	0.112226	18.228	2.320856	0.000143
133.9	0.112399	18.424	2.345811	0.000145
134	0.11255	18.62	2.370767	0.000146
134.1	0.112758	18.816	2.395722	0.000148
134.2	0.112939	19.012	2.420677	0.00015
134.3	0.113059	19.208	2.445633	0.000151
134.4	0.113195	19.404	2.470588	0.000153
134.5	0.113347	19.6	2.495544	0.000154
134.6	0.113498	19.796	2.520499	0.000156
134.7	0.113692	19.992	2.545455	0.000157
134.8	0.113855	20.188	2.57041	0.000159
134.9	0.114008	20.384	2.595366	0.000161
135	0.114115	20.58	2.620321	0.000162
135.1	0.11425	20.776	2.645276	0.000163
135.2	0.114436	20.972	2.670232	0.000165
135.3	0.114553	21.168	2.695187	0.000166
135.4	0.114766	21.364	2.720143	0.000168
135.5	0.114869	21.56	2.745098	0.000169
135.6	0.115093	21.756	2.770054	0.000172
135.7	0.115203	21.952	2.795009	0.000173
135.8	0.115286	22.148	2.819964	0.000173
135.9	0.115463	22.344	2.84492	0.000175
136	0.11562	22.54	2.869875	0.000177

136.1	0.115796	22.736	2.894831	0.000179
136.2	0.115875	22.932	2.919786	0.000179
136.3	0.11601	23.128	2.944742	0.000181
136.4	0.1162	23.324	2.969697	0.000183
136.5	0.116318	23.52	2.994653	0.000184
136.6	0.116415	23.716	3.019608	0.000185
136.7	0.116646	23.912	3.044563	0.000187
136.8	0.116831	24.108	3.069519	0.000189
136.9	0.116911	24.304	3.094474	0.00019
137	0.117137	24.5	3.11943	0.000192
137.1	0.11725	24.696	3.144385	0.000193
137.2	0.117335	24.892	3.169341	0.000194
137.3	0.11753	25.088	3.194296	0.000196
137.4	0.11778	25.284	3.219251	0.000198
137.5	0.117853	25.48	3.244207	0.000199
137.6	0.117979	25.676	3.269162	0.0002
137.7	0.118252	25.872	3.294118	0.000203
137.8	0.118322	26.068	3.319073	0.000204
137.9	0.118476	26.264	3.344029	0.000205
138	0.118648	26.46	3.368984	0.000207
138.1	0.118676	26.656	3.39394	0.000207
138.2	0.11873	26.852	3.418895	0.000208
138.3	0.118911	27.048	3.44385	0.00021
138.4	0.119231	27.244	3.468806	0.000213
138.5	0.119402	27.44	3.493761	0.000215
138.6	0.119435	27.636	3.518717	0.000215
138.7	0.119677	27.832	3.543672	0.000217
138.8	0.119835	28.028	3.568628	0.000219
138.9	0.119851	28.224	3.593583	0.000219
139	0.120062	28.42	3.618538	0.000221
139.1	0.120267	28.616	3.643494	0.000223
139.2	0.120398	28.812	3.668449	0.000225
139.3	0.12046	29.008	3.693405	0.000225
139.4	0.120581	29.204	3.71836	0.000226
139.5	0.12071	29.4	3.743316	0.000228
139.6	0.120925	29.596	3.768271	0.00023
139.7	0.12099	29.792	3.793227	0.00023
139.8	0.121059	29.988	3.818182	0.000231
139.9	0.121272	30.184	3.843137	0.000233
140	0.121374	30.38	3.868093	0.000234
140.1	0.121563	30.576	3.893048	0.000236
140.2	0.121757	30.772	3.918004	0.000238
140.3	0.121817	30.968	3.942959	0.000239
140.4	0.121936	31.164	3.967915	0.00024
140.5	0.122149	31.36	3.99287	0.000242
140.6	0.12226	31.556	4.017826	0.000243
140.7	0.122428	31.752	4.042781	0.000245
140.8	0.122549	31.948	4.067736	0.000246
140.9	0.122703	32.144	4.092692	0.000248
141	0.122878	32.34	4.117647	0.000249
141.1	0.122929	32.536	4.142603	0.00025
141.2	0.123115	32.732	4.167558	0.000252
141.3	0.123331	32.928	4.192514	0.000254
141.4	0.123555	33.124	4.217469	0.000256
141.5	0.123624	33.32	4.242424	0.000257

141.6	0.12378	33.516	4.26738	0.000258
141.7	0.123891	33.712	4.292335	0.000259
141.8	0.12396	33.908	4.317291	0.00026
141.9	0.124132	34.104	4.342246	0.000262
142	0.124369	34.3	4.367202	0.000264
142.1	0.124465	34.496	4.392157	0.000265
142.2	0.124561	34.692	4.417113	0.000266
142.3	0.124754	34.888	4.442068	0.000268
142.4	0.124936	35.084	4.467023	0.00027
142.5	0.125033	35.28	4.491979	0.000271
142.6	0.125102	35.476	4.516934	0.000272
142.7	0.125283	35.672	4.54189	0.000273
142.8	0.125441	35.868	4.566845	0.000275
142.9	0.125556	36.064	4.591801	0.000276
143	0.125734	36.26	4.616756	0.000278
143.1	0.125899	36.456	4.641711	0.00028
143.2	0.126025	36.652	4.666667	0.000281
143.3	0.126178	36.848	4.691622	0.000282
143.4	0.126338	37.044	4.716578	0.000284
143.5	0.126454	37.24	4.741533	0.000285
143.6	0.126606	37.436	4.766489	0.000287
143.7	0.126779	37.632	4.791444	0.000288
143.8	0.126884	37.828	4.8164	0.000289
143.9	0.127002	38.024	4.841355	0.000291
144	0.127137	38.22	4.86631	0.000292
144.1	0.127287	38.416	4.891266	0.000293
144.2	0.127414	38.612	4.916221	0.000295
144.3	0.127541	38.808	4.941177	0.000296
144.4	0.12765	39.004	4.966132	0.000297
144.5	0.127806	39.2	4.991088	0.000299
144.6	0.127963	39.396	5.016043	0.0003
144.7	0.128112	39.592	5.040998	0.000302
144.8	0.128187	39.788	5.065954	0.000302
144.9	0.128339	39.984	5.090909	0.000304
145	0.128494	40.18	5.115865	0.000306
145.1	0.128617	40.376	5.14082	0.000307
145.2	0.128806	40.572	5.165776	0.000309
145.3	0.128906	40.768	5.190731	0.00031
145.4	0.129074	40.964	5.215687	0.000311
145.5	0.129188	41.16	5.240642	0.000312
145.6	0.129333	41.356	5.265597	0.000314
145.7	0.129518	41.552	5.290553	0.000316
145.8	0.129629	41.748	5.315508	0.000317
145.9	0.129803	41.944	5.340464	0.000319
146	0.129908	42.14	5.365419	0.00032
146.1	0.130022	42.336	5.390375	0.000321
146.2	0.130182	42.532	5.41533	0.000322
146.3	0.130365	42.728	5.440285	0.000324
146.4	0.13048	42.924	5.465241	0.000325
146.5	0.130562	43.12	5.490196	0.000326
146.6	0.130728	43.316	5.515152	0.000328
146.7	0.130845	43.512	5.540107	0.000329
146.8	0.131013	43.708	5.565063	0.000331
146.9	0.131203	43.904	5.590018	0.000333
147	0.131298	44.1	5.614974	0.000334

147.1	0.131429	44.296	5.639929	0.000335
147.2	0.131564	44.492	5.664884	0.000336
147.3	0.131706	44.688	5.68984	0.000338
147.4	0.131845	44.884	5.714795	0.000339
147.5	0.131947	45.08	5.739751	0.00034
147.6	0.132103	45.276	5.764706	0.000342
147.7	0.132239	45.472	5.789662	0.000343
147.8	0.132366	45.668	5.814617	0.000344
147.9	0.13251	45.864	5.839572	0.000346
148	0.132607	46.06	5.864528	0.000347
148.1	0.13281	46.256	5.889483	0.000349
148.2	0.132902	46.452	5.914439	0.00035
148.3	0.133037	46.648	5.939394	0.000351
148.4	0.133157	46.844	5.96435	0.000352
148.5	0.13333	47.04	5.989305	0.000354
148.6	0.133426	47.236	6.014261	0.000355
148.7	0.133566	47.432	6.039216	0.000356
148.8	0.133699	47.628	6.064171	0.000358
148.9	0.133807	47.824	6.089127	0.000359
149	0.133904	48.02	6.114082	0.00036
149.1	0.13405	48.216	6.139038	0.000361
149.2	0.13421	48.412	6.163993	0.000363
149.3	0.134357	48.608	6.188949	0.000364
149.4	0.134494	48.804	6.213904	0.000366
149.5	0.134619	49	6.238859	0.000367
149.6	0.134784	49.196	6.263815	0.000368
149.7	0.134931	49.392	6.28877	0.00037
149.8	0.135046	49.588	6.313726	0.000371
149.9	0.135169	49.784	6.338681	0.000372
150	0.135362	49.98	6.363637	0.000374
150.1	0.135461	50.176	6.388592	0.000375
150.2	0.135573	50.372	6.413548	0.000376
150.3	0.135744	50.568	6.438503	0.000378
150.4	0.135902	50.764	6.463458	0.00038
150.5	0.136008	50.96	6.488414	0.000381
150.6	0.136126	51.156	6.513369	0.000382
150.7	0.136261	51.352	6.538325	0.000383
150.8	0.136396	51.548	6.56328	0.000385
150.9	0.136542	51.744	6.588236	0.000386
151	0.136654	51.94	6.613191	0.000387
151.1	0.13678	52.136	6.638146	0.000388
151.2	0.136883	52.332	6.663102	0.000389
151.3	0.137057	52.528	6.688057	0.000391
151.4	0.137189	52.724	6.713013	0.000392
151.5	0.137306	52.92	6.737968	0.000394
151.6	0.137409	53.116	6.762924	0.000395
151.7	0.137566	53.312	6.787879	0.000396
151.8	0.137705	53.508	6.812835	0.000398
151.9	0.13782	53.704	6.83779	0.000399
152	0.137934	53.9	6.862745	0.0004
152.1	0.138073	54.096	6.887701	0.000401
152.2	0.138159	54.292	6.912656	0.000402
152.3	0.138315	54.488	6.937612	0.000404
152.4	0.138464	54.684	6.962567	0.000405
152.5	0.138595	54.88	6.987523	0.000407

152.6	0.1387	55.076	7.012478	0.000408
152.7	0.13886	55.272	7.037433	0.000409
152.8	0.139001	55.468	7.062389	0.000411
152.9	0.139127	55.664	7.087344	0.000412
153	0.13928	55.86	7.1123	0.000413
153.1	0.13939	56.056	7.137255	0.000414
153.2	0.139495	56.252	7.162211	0.000416
153.3	0.13968	56.448	7.187166	0.000417
153.4	0.139808	56.644	7.212122	0.000419
153.5	0.139922	56.84	7.237077	0.00042
153.6	0.14008	57.036	7.262032	0.000421
153.7	0.140214	57.232	7.286988	0.000423
153.8	0.140338	57.428	7.311943	0.000424
153.9	0.140464	57.624	7.336899	0.000425
154	0.140578	57.82	7.361854	0.000426
154.1	0.14074	58.016	7.38681	0.000428
154.2	0.140861	58.212	7.411765	0.000429
154.3	0.140967	58.408	7.43672	0.00043
154.4	0.141065	58.604	7.461676	0.000431
154.5	0.141207	58.8	7.486631	0.000433
154.6	0.141316	58.996	7.511587	0.000434
154.7	0.141409	59.192	7.536542	0.000435
154.8	0.141571	59.388	7.561498	0.000436
154.9	0.141708	59.584	7.586453	0.000438
155	0.141797	59.78	7.611409	0.000439
155.1	0.141936	59.976	7.636364	0.00044
155.2	0.142047	60.172	7.661319	0.000441
155.3	0.142197	60.368	7.686275	0.000443
155.4	0.142324	60.564	7.71123	0.000444
155.5	0.14247	60.76	7.736186	0.000445
155.6	0.142616	60.956	7.761141	0.000447
155.7	0.142724	61.152	7.786097	0.000448
155.8	0.142807	61.348	7.811052	0.000449
155.9	0.142953	61.544	7.836008	0.00045
156	0.143108	61.74	7.860963	0.000452
156.1	0.143253	61.936	7.885918	0.000453
156.2	0.143375	62.132	7.910874	0.000454
156.3	0.143528	62.328	7.935829	0.000456
156.4	0.143612	62.524	7.960785	0.000457
156.5	0.143736	62.72	7.98574	0.000458
156.6	0.143881	62.916	8.010696	0.000459
156.7	0.144031	63.112	8.035651	0.000461
156.8	0.144144	63.308	8.060606	0.000462
156.9	0.14429	63.504	8.085562	0.000463
157	0.144434	63.7	8.110517	0.000465
157.1	0.144554	63.896	8.135473	0.000466
157.2	0.144671	64.092	8.160428	0.000467
157.3	0.144816	64.288	8.185384	0.000469
157.4	0.144912	64.484	8.210339	0.00047
157.5	0.145069	64.68	8.235295	0.000471
157.6	0.145179	64.876	8.26025	0.000472
157.7	0.145331	65.072	8.285205	0.000474
157.8	0.145444	65.268	8.310161	0.000475
157.9	0.145549	65.464	8.335116	0.000476
158	0.145681	65.66	8.360072	0.000477

158.1	0.145828	65.856	8.385027	0.000479
158.2	0.145914	66.052	8.409983	0.00048
158.3	0.146022	66.248	8.434938	0.000481
158.4	0.146195	66.444	8.459893	0.000483
158.5	0.146322	66.64	8.484849	0.000484

B.1.4 Elastic Modulus test results of SFRC at 600ºC temperature.

Time	Absolute	force	stress	Strain
65.2	0.146233	0	0	0
65.3	0.146451	0.196	0.024955	2.18E-06
65.4	0.146689	0.392	0.049911	4.55E-06
65.5	0.146927	0.588	0.074866	6.94E-06
65.6	0.147222	0.784	0.099822	9.89E-06
65.7	0.147479	0.98	0.124777	1.25E-05
65.8	0.14767	1.176	0.149733	1.44E-05
65.9	0.147988	1.372	0.174688	1.75E-05
66	0.148262	1.568	0.199644	2.03E-05
66.1	0.148466	1.764	0.224599	2.23E-05
66.2	0.148733	1.96	0.249554	2.5E-05
66.3	0.149033	2.156	0.27451	2.8E-05
66.4	0.149265	2.352	0.299465	3.03E-05
66.5	0.149497	2.548	0.324421	3.26E-05
66.6	0.149845	2.744	0.349376	3.61E-05
66.7	0.150054	2.94	0.374332	3.82E-05
66.8	0.150228	3.136	0.399287	3.99E-05
66.9	0.150595	3.332	0.424242	4.36E-05
67	0.150882	3.528	0.449198	4.65E-05
67.1	0.151132	3.724	0.474153	4.9E-05
67.2	0.151356	3.92	0.499109	5.12E-05
67.3	0.151651	4.116	0.524064	5.42E-05
67.4	0.151848	4.312	0.54902	5.61E-05
67.5	0.152043	4.508	0.573975	5.81E-05
67.6	0.15242	4.704	0.598931	6.19E-05
67.7	0.152733	4.9	0.623886	6.5E-05
67.8	0.152959	5.096	0.648841	6.73E-05
67.9	0.153178	5.292	0.673797	6.94E-05
68	0.153525	5.488	0.698752	7.29E-05
68.1	0.153819	5.684	0.723708	7.59E-05
68.2	0.154042	5.88	0.748663	7.81E-05
68.3	0.154345	6.076	0.773619	8.11E-05
68.4	0.154594	6.272	0.798574	8.36E-05
68.5	0.154936	6.468	0.823529	8.7E-05
68.6	0.155164	6.664	0.848485	8.93E-05
68.7	0.155459	6.86	0.87344	9.23E-05
68.8	0.155671	7.056	0.898396	9.44E-05
68.9	0.155956	7.252	0.923351	9.72E-05
69	0.156273	7.448	0.948307	0.0001
69.1	0.156498	7.644	0.973262	0.000103
69.2	0.156763	7.84	0.998218	0.000105

69.3	0.157017	8.036	1.023173	0.000108
69.4	0.157333	8.232	1.048128	0.000111
69.5	0.157545	8.428	1.073084	0.000113
69.6	0.157815	8.624	1.098039	0.000116
69.7	0.158112	8.82	1.122995	0.000119
69.8	0.158374	9.016	1.14795	0.000121
69.9	0.158643	9.212	1.172906	0.000124
70	0.158875	9.408	1.197861	0.000126
70.1	0.159235	9.604	1.222816	0.00013
70.2	0.159404	9.8	1.247772	0.000132
70.3	0.159662	9.996	1.272727	0.000134
70.4	0.159912	10.192	1.297683	0.000137
70.5	0.160233	10.388	1.322638	0.00014
70.6	0.160478	10.584	1.347594	0.000142
70.7	0.160685	10.78	1.372549	0.000145
70.8	0.161079	10.976	1.397505	0.000148
70.9	0.161302	11.172	1.42246	0.000151
71	0.161552	11.368	1.447415	0.000153
71.1	0.161813	11.564	1.472371	0.000156
71.2	0.162134	11.76	1.497326	0.000159
71.3	0.162381	11.956	1.522282	0.000161
71.4	0.162601	12.152	1.547237	0.000164
71.5	0.162972	12.348	1.572193	0.000167
71.6	0.163245	12.544	1.597148	0.00017
71.7	0.16353	12.74	1.622103	0.000173
71.8	0.163793	12.936	1.647059	0.000176
71.9	0.164133	13.132	1.672014	0.000179
72	0.164354	13.328	1.69697	0.000181
72.1	0.164519	13.524	1.721925	0.000183
72.2	0.164922	13.72	1.746881	0.000187
72.3	0.165106	13.916	1.771836	0.000189
72.4	0.165339	14.112	1.796792	0.000191
72.5	0.165605	14.308	1.821747	0.000194
72.6	0.165849	14.504	1.846702	0.000196
72.7	0.166082	14.7	1.871658	0.000198
72.8	0.166344	14.896	1.896613	0.000201
72.9	0.166672	15.092	1.921569	0.000204
73	0.166895	15.288	1.946524	0.000207
73.1	0.167118	15.484	1.97148	0.000209
73.2	0.167368	15.68	1.996435	0.000211
73.3	0.167657	15.876	2.02139	0.000214
73.4	0.167917	16.072	2.046346	0.000217
73.5	0.168119	16.268	2.071301	0.000219
73.6	0.168394	16.464	2.096257	0.000222
73.7	0.168628	16.66	2.121212	0.000224
73.8	0.168832	16.856	2.146168	0.000226
73.9	0.169078	17.052	2.171123	0.000228
74	0.169303	17.248	2.196079	0.000231
74.1	0.169622	17.444	2.221034	0.000234
74.2	0.169904	17.64	2.245989	0.000237
74.3	0.170103	17.836	2.270945	0.000239
74.4	0.170336	18.032	2.2959	0.000241
74.5	0.170579	18.228	2.320856	0.000243
74.6	0.17085	18.424	2.345811	0.000246
74.7	0.171076	18.62	2.370767	0.000248

74.8	0.171309	18.816	2.395722	0.000251
74.9	0.171598	19.012	2.420677	0.000254
75	0.17187	19.208	2.445633	0.000256
75.1	0.172084	19.404	2.470588	0.000259
75.2	0.172277	19.6	2.495544	0.00026
75.3	0.172565	19.796	2.520499	0.000263
75.4	0.172812	19.992	2.545455	0.000266
75.5	0.172995	20.188	2.57041	0.000268
75.6	0.173272	20.384	2.595366	0.00027
75.7	0.173519	20.58	2.620321	0.000273
75.8	0.173707	20.776	2.645276	0.000275
75.9	0.173899	20.972	2.670232	0.000277
76	0.174154	21.168	2.695187	0.000279
76.1	0.174427	21.364	2.720143	0.000282
76.2	0.174616	21.56	2.745098	0.000284
76.3	0.174862	21.756	2.770054	0.000286
76.4	0.175121	21.952	2.795009	0.000289
76.5	0.175348	22.148	2.819964	0.000291
76.6	0.175598	22.344	2.84492	0.000294
76.7	0.175816	22.54	2.869875	0.000296
76.8	0.176108	22.736	2.894831	0.000299
76.9	0.176295	22.932	2.919786	0.000301
77	0.176523	23.128	2.944742	0.000303
77.1	0.176768	23.324	2.969697	0.000305
77.2	0.177023	23.52	2.994653	0.000308
77.3	0.177273	23.716	3.019608	0.00031
77.4	0.177478	23.912	3.044563	0.000312
77.5	0.177691	24.108	3.069519	0.000315
77.6	0.177955	24.304	3.094474	0.000317
77.7	0.17817	24.5	3.11943	0.000319
77.8	0.178406	24.696	3.144385	0.000322
77.9	0.178564	24.892	3.169341	0.000323
78	0.178823	25.088	3.194296	0.000326
78.1	0.179034	25.284	3.219251	0.000328
78.2	0.179227	25.48	3.244207	0.00033
78.3	0.179537	25.676	3.269162	0.000333
78.4	0.17975	25.872	3.294118	0.000335
78.5	0.179979	26.068	3.319073	0.000337
78.6	0.180217	26.264	3.344029	0.00034
78.7	0.180446	26.46	3.368984	0.000342
78.8	0.180676	26.656	3.39394	0.000344
78.9	0.180839	26.852	3.418895	0.000346
79	0.18113	27.048	3.44385	0.000349
79.1	0.181287	27.244	3.468806	0.000351
79.2	0.181535	27.44	3.493761	0.000353
79.3	0.18185	27.636	3.518717	0.000356
79.4	0.182031	27.832	3.543672	0.000358
79.5	0.182244	28.028	3.568628	0.00036
79.6	0.182481	28.224	3.593583	0.000362
79.7	0.182694	28.42	3.618538	0.000365
79.8	0.182869	28.616	3.643494	0.000366
79.9	0.183102	28.812	3.668449	0.000369
80	0.183362	29.008	3.693405	0.000371
80.1	0.183557	29.204	3.71836	0.000373
80.2	0.183709	29.4	3.743316	0.000375

80.3	0.18399	29.596	3.768271	0.000378
80.4	0.184197	29.792	3.793227	0.00038
80.5	0.184382	29.988	3.818182	0.000381
80.6	0.184655	30.184	3.843137	0.000384
80.7	0.184865	30.38	3.868093	0.000386
80.8	0.18508	30.576	3.893048	0.000388
80.9	0.185319	30.772	3.918004	0.000391
81	0.185535	30.968	3.942959	0.000393
81.1	0.185729	31.164	3.967915	0.000395
81.2	0.185905	31.36	3.99287	0.000397
81.3	0.186207	31.556	4.017826	0.0004
81.4	0.186413	31.752	4.042781	0.000402
81.5	0.186575	31.948	4.067736	0.000403
81.6	0.186884	32.144	4.092692	0.000407
81.7	0.187032	32.34	4.117647	0.000408
81.8	0.187258	32.536	4.142603	0.00041
81.9	0.187629	32.732	4.167558	0.000414
82	0.187772	32.928	4.192514	0.000415
82.1	0.187848	33.124	4.217469	0.000416
82.2	0.188198	33.32	4.242424	0.00042
82.3	0.188365	33.516	4.26738	0.000421
82.4	0.188619	33.712	4.292335	0.000424
82.5	0.18876	33.908	4.317291	0.000425
82.6	0.189055	34.104	4.342246	0.000428

B.1.5 Elastic Modulus test results of SFRC at 800°C temperature

Time	Absolute	Force	Stress	Strain
118.3	0.752868	0	0	0
118.4	0.753406	0.196	0.024955	5.39E-06
118.5	0.753903	0.392	0.049911	1.03E-05
118.6	0.754457	0.588	0.074866	1.59E-05
118.7	0.755007	0.784	0.099822	2.14E-05
118.8	0.755538	0.98	0.124777	2.67E-05
118.9	0.756072	1.176	0.149733	3.2E-05
119	0.756689	1.372	0.174688	3.82E-05
119.1	0.757322	1.568	0.199644	4.45E-05
119.2	0.757819	1.764	0.224599	4.95E-05
119.3	0.758303	1.96	0.249554	5.43E-05
119.4	0.758858	2.156	0.27451	5.99E-05
119.5	0.759387	2.352	0.299465	6.52E-05
119.6	0.760081	2.548	0.324421	7.21E-05
119.7	0.760604	2.744	0.349376	7.74E-05
119.8	0.761099	2.94	0.374332	8.23E-05
119.9	0.761761	3.136	0.399287	8.89E-05
120	0.762391	3.332	0.424242	9.52E-05
120.1	0.763028	3.528	0.449198	0.000102
120.2	0.763547	3.724	0.474153	0.000107

120.3	0.764173	3.92	0.499109	0.000113
120.4	0.764745	4.116	0.524064	0.000119
120.5	0.765225	4.312	0.54902	0.000124
120.6	0.765877	4.508	0.573975	0.00013
120.7	0.766352	4.704	0.598931	0.000135
120.8	0.766918	4.9	0.623886	0.00014
120.9	0.767492	5.096	0.648841	0.000146
121	0.768031	5.292	0.673797	0.000152
121.1	0.768643	5.488	0.698752	0.000158
121.2	0.769194	5.684	0.723708	0.000163
121.3	0.769762	5.88	0.748663	0.000169
121.4	0.770339	6.076	0.773619	0.000175
121.5	0.770893	6.272	0.798574	0.00018
121.6	0.771508	6.468	0.823529	0.000186
121.7	0.772098	6.664	0.848485	0.000192
121.8	0.77261	6.86	0.87344	0.000197
121.9	0.77319	7.056	0.898396	0.000203
122	0.773729	7.252	0.923351	0.000209
122.1	0.774321	7.448	0.948307	0.000215
122.2	0.774898	7.644	0.973262	0.00022
122.3	0.775472	7.84	0.998218	0.000226
122.4	0.776042	8.036	1.023173	0.000232
122.5	0.776633	8.232	1.048128	0.000238
122.6	0.777232	8.428	1.073084	0.000244
122.7	0.777841	8.624	1.098039	0.00025
122.8	0.778405	8.82	1.122995	0.000255
122.9	0.778899	9.016	1.14795	0.00026
123	0.779472	9.212	1.172906	0.000266
123.1	0.780088	9.408	1.197861	0.000272
123.2	0.780708	9.604	1.222816	0.000278
123.3	0.781238	9.8	1.247772	0.000284
123.4	0.781703	9.996	1.272727	0.000288
123.5	0.782316	10.192	1.297683	0.000294
123.6	0.782944	10.388	1.322638	0.000301
123.7	0.783467	10.584	1.347594	0.000306
123.8	0.784048	10.78	1.372549	0.000312
123.9	0.784645	10.976	1.397505	0.000318
124	0.78529	11.172	1.42246	0.000324
124.1	0.78595	11.368	1.447415	0.000331
124.2	0.786423	11.564	1.472371	0.000336
124.3	0.787018	11.76	1.497326	0.000341
124.4	0.787588	11.956	1.522282	0.000347
124.5	0.788076	12.152	1.547237	0.000352
124.6	0.788661	12.348	1.572193	0.000358
124.7	0.789202	12.544	1.597148	0.000363
124.8	0.789741	12.74	1.622103	0.000369
124.9	0.79024	12.936	1.647059	0.000374
125	0.79075	13.132	1.672014	0.000379
125.1	0.791271	13.328	1.69697	0.000384
125.2	0.791828	13.524	1.721925	0.00039
125.3	0.792349	13.72	1.746881	0.000395
125.4	0.792874	13.916	1.771836	0.0004
125.5	0.793408	14.112	1.796792	0.000405
125.6	0.793887	14.308	1.821747	0.00041
125.7	0.794388	14.504	1.846702	0.000415

125.8	0.794977	14.7	1.871658	0.000421
125.9	0.795462	14.896	1.896613	0.000426
126	0.796008	15.092	1.921569	0.000431
126.1	0.79653	15.288	1.946524	0.000437
126.2	0.797059	15.484	1.97148	0.000442
126.3	0.797582	15.68	1.996435	0.000447
126.4	0.798197	15.876	2.02139	0.000453
126.5	0.798736	16.072	2.046346	0.000459
126.6	0.799176	16.268	2.071301	0.000463
126.7	0.799703	16.464	2.096257	0.000468
126.8	0.800221	16.66	2.121212	0.000474
126.9	0.800682	16.856	2.146168	0.000478
127	0.801178	17.052	2.171123	0.000483
127.1	0.801663	17.248	2.196079	0.000488
127.2	0.802185	17.444	2.221034	0.000493
127.3	0.802674	17.64	2.245989	0.000498
127.4	0.803254	17.836	2.270945	0.000504
127.5	0.803829	18.032	2.2959	0.00051
127.6	0.804257	18.228	2.320856	0.000514
127.7	0.804776	18.424	2.345811	0.000519
127.8	0.805244	18.62	2.370767	0.000524
127.9	0.805752	18.816	2.395722	0.000529
128	0.806274	19.012	2.420677	0.000534
128.1	0.80678	19.208	2.445633	0.000539
128.2	0.807287	19.404	2.470588	0.000544
128.3	0.807841	19.6	2.495544	0.00055
128.4	0.808368	19.796	2.520499	0.000555
128.5	0.808865	19.992	2.545455	0.00056
128.6	0.809367	20.188	2.57041	0.000565
128.7	0.809833	20.384	2.595366	0.00057
128.8	0.810374	20.58	2.620321	0.000575
128.9	0.810827	20.776	2.645276	0.00058
129	0.811275	20.972	2.670232	0.000584
129.1	0.811787	21.168	2.695187	0.000589
129.2	0.812258	21.364	2.720143	0.000594
129.3	0.812748	21.56	2.745098	0.000599
129.4	0.813238	21.756	2.770054	0.000604
129.5	0.8137	21.952	2.795009	0.000608
129.6	0.814214	22.148	2.819964	0.000613
129.7	0.81477	22.344	2.84492	0.000619
129.8	0.8153	22.54	2.869875	0.000624
129.9	0.815644	22.736	2.894831	0.000628
130	0.8161	22.932	2.919786	0.000632
130.1	0.816663	23.128	2.944742	0.000638
130.2	0.817147	23.324	2.969697	0.000643
130.3	0.817675	23.52	2.994653	0.000648
130.4	0.818151	23.716	3.019608	0.000653
130.5	0.818595	23.912	3.044563	0.000657
130.6	0.819038	24.108	3.069519	0.000662
130.7	0.819536	24.304	3.094474	0.000667
130.8	0.820029	24.5	3.11943	0.000672
130.9	0.82044	24.696	3.144385	0.000676
131	0.820877	24.892	3.169341	0.00068
131.1	0.821316	25.088	3.194296	0.000684
131.2	0.821831	25.284	3.219251	0.00069

131.3	0.822321	25.48	3.244207	0.000695
131.4	0.822776	25.676	3.269162	0.000699
131.5	0.823225	25.872	3.294118	0.000704
131.6	0.823746	26.068	3.319073	0.000709
131.7	0.824255	26.264	3.344029	0.000714
131.8	0.824716	26.46	3.368984	0.000718
131.9	0.82515	26.656	3.39394	0.000723
132	0.825648	26.852	3.418895	0.000728
132.1	0.826225	27.048	3.44385	0.000734
132.2	0.826647	27.244	3.468806	0.000738
132.3	0.827046	27.44	3.493761	0.000742
132.4	0.82743	27.636	3.518717	0.000746
132.5	0.827998	27.832	3.543672	0.000751
132.6	0.82848	28.028	3.568628	0.000756
132.7	0.828919	28.224	3.593583	0.000761
132.8	0.829242	28.42	3.618538	0.000764
132.9	0.829833	28.616	3.643494	0.00077
133	0.830222	28.812	3.668449	0.000774
133.1	0.830749	29.008	3.693405	0.000779
133.2	0.83112	29.204	3.71836	0.000783
133.3	0.831698	29.4	3.743316	0.000788
133.4	0.832136	29.596	3.768271	0.000793
133.5	0.832545	29.792	3.793227	0.000797
133.6	0.832841	29.988	3.818182	0.0008
133.7	0.833352	30.184	3.843137	0.000805
133.8	0.833953	30.38	3.868093	0.000811
133.9	0.83427	30.576	3.893048	0.000814
134	0.834862	30.772	3.918004	0.00082
134.1	0.83526	30.968	3.942959	0.000824
134.2	0.83569	31.164	3.967915	0.000828
134.3	0.836111	31.36	3.99287	0.000832
134.4	0.83641	31.556	4.017826	0.000835
134.5	0.836963	31.752	4.042781	0.000841
134.6	0.83752	31.948	4.067736	0.000847
134.7	0.837804	32.144	4.092692	0.000849

B.1.6 Elastic Modulus test results of SFRGC(Na) at ambient temperature.

Time	Absolute	Force	Stress	Strain
189.3	0.010621	0	0	0
189.4	0.010719	0.196	0.024955	9.78E-07
189.5	0.0108	0.392	0.049911	1.79E-06
189.6	0.010881	0.588	0.074866	2.6E-06
189.7	0.010939	0.784	0.099822	3.18E-06
189.8	0.011041	0.98	0.124777	4.2E-06
189.9	0.011128	1.176	0.149733	5.07E-06
190	0.011193	1.372	0.174688	5.72E-06
190.1	0.011298	1.568	0.199644	6.77E-06
190.2	0.0114	1.764	0.224599	7.78E-06
190.3	0.01146	1.96	0.249554	8.39E-06

190.4	0.011529	2.156	0.27451	9.07E-06
190.5	0.011581	2.352	0.299465	9.6E-06
190.6	0.011681	2.548	0.324421	1.06E-05
190.7	0.011761	2.744	0.349376	1.14E-05
190.8	0.011832	2.94	0.374332	1.21E-05
190.9	0.011923	3.136	0.399287	1.3E-05
191	0.011995	3.332	0.424242	1.37E-05
191.1	0.012104	3.528	0.449198	1.48E-05
191.2	0.012145	3.724	0.474153	1.52E-05
191.3	0.012217	3.92	0.499109	1.6E-05
191.4	0.012301	4.116	0.524064	1.68E-05
191.5	0.012378	4.312	0.54902	1.76E-05
191.6	0.012443	4.508	0.573975	1.82E-05
191.7	0.012538	4.704	0.598931	1.92E-05
191.8	0.012649	4.9	0.623886	2.03E-05
191.9	0.012713	5.096	0.648841	2.09E-05
192	0.012781	5.292	0.673797	2.16E-05
192.1	0.012869	5.488	0.698752	2.25E-05
192.2	0.012966	5.684	0.723708	2.34E-05
192.3	0.013047	5.88	0.748663	2.43E-05
192.4	0.013114	6.076	0.773619	2.49E-05
192.5	0.013208	6.272	0.798574	2.59E-05
192.6	0.013309	6.468	0.823529	2.69E-05
192.7	0.01336	6.664	0.848485	2.74E-05
192.8	0.013451	6.86	0.87344	2.83E-05
192.9	0.013529	7.056	0.898396	2.91E-05
193	0.013598	7.252	0.923351	2.98E-05
193.1	0.013687	7.448	0.948307	3.07E-05
193.2	0.013783	7.644	0.973262	3.16E-05
193.3	0.013882	7.84	0.998218	3.26E-05
193.4	0.013912	8.036	1.023173	3.29E-05
193.5	0.014006	8.232	1.048128	3.38E-05
193.6	0.014081	8.428	1.073084	3.46E-05
193.7	0.014144	8.624	1.098039	3.52E-05
193.8	0.014221	8.82	1.122995	3.6E-05
193.9	0.014319	9.016	1.14795	3.7E-05
194	0.014414	9.212	1.172906	3.79E-05
194.1	0.014481	9.408	1.197861	3.86E-05
194.2	0.014496	9.604	1.222816	3.87E-05
194.3	0.014597	9.8	1.247772	3.98E-05
194.4	0.014686	9.996	1.272727	4.06E-05
194.5	0.014791	10.192	1.297683	4.17E-05
194.6	0.014871	10.388	1.322638	4.25E-05
194.7	0.014904	10.584	1.347594	4.28E-05
194.8	0.014998	10.78	1.372549	4.38E-05
194.9	0.015093	10.976	1.397505	4.47E-05
195	0.01521	11.172	1.42246	4.59E-05
195.1	0.015288	11.368	1.447415	4.67E-05
195.2	0.015343	11.564	1.472371	4.72E-05
195.3	0.015443	11.76	1.497326	4.82E-05
195.4	0.015565	11.956	1.522282	4.94E-05
195.5	0.015617	12.152	1.547237	5E-05
195.6	0.015651	12.348	1.572193	5.03E-05
195.7	0.015738	12.544	1.597148	5.12E-05
195.8	0.015815	12.74	1.622103	5.19E-05

195.9	0.015927	12.936	1.647059	5.31E-05
196	0.016	13.132	1.672014	5.38E-05
196.1	0.016048	13.328	1.69697	5.43E-05
196.2	0.016083	13.524	1.721925	5.46E-05
196.3	0.01622	13.72	1.746881	5.6E-05
196.4	0.01634	13.916	1.771836	5.72E-05
196.5	0.016382	14.112	1.796792	5.76E-05
196.6	0.016497	14.308	1.821747	5.88E-05
196.7	0.016584	14.504	1.846702	5.96E-05
196.8	0.016618	14.7	1.871658	6E-05
196.9	0.016712	14.896	1.896613	6.09E-05
197	0.016809	15.092	1.921569	6.19E-05
197.1	0.016887	15.288	1.946524	6.27E-05
197.2	0.016958	15.484	1.97148	6.34E-05
197.3	0.017072	15.68	1.996435	6.45E-05
197.4	0.017142	15.876	2.02139	6.52E-05
197.5	0.017222	16.072	2.046346	6.6E-05
197.6	0.017289	16.268	2.071301	6.67E-05
197.7	0.017392	16.464	2.096257	6.77E-05
197.8	0.017438	16.66	2.121212	6.82E-05
197.9	0.017498	16.856	2.146168	6.88E-05
198	0.017609	17.052	2.171123	6.99E-05
198.1	0.017703	17.248	2.196079	7.08E-05
198.2	0.0178	17.444	2.221034	7.18E-05
198.3	0.017871	17.64	2.245989	7.25E-05
198.4	0.017942	17.836	2.270945	7.32E-05
198.5	0.018015	18.032	2.2959	7.39E-05
198.6	0.018091	18.228	2.320856	7.47E-05
198.7	0.018188	18.424	2.345811	7.57E-05
198.8	0.018258	18.62	2.370767	7.64E-05
198.9	0.018341	18.816	2.395722	7.72E-05
199	0.01846	19.012	2.420677	7.84E-05
199.1	0.018549	19.208	2.445633	7.93E-05
199.2	0.018598	19.404	2.470588	7.98E-05
199.3	0.018661	19.6	2.495544	8.04E-05
199.4	0.018729	19.796	2.520499	8.11E-05
199.5	0.018822	19.992	2.545455	8.2E-05
199.6	0.018886	20.188	2.57041	8.26E-05
199.7	0.018983	20.384	2.595366	8.36E-05
199.8	0.01909	20.58	2.620321	8.47E-05
199.9	0.019174	20.776	2.645276	8.55E-05
200	0.01924	20.972	2.670232	8.62E-05
200.1	0.01929	21.168	2.695187	8.67E-05
200.2	0.019378	21.364	2.720143	8.76E-05
200.3	0.019466	21.56	2.745098	8.84E-05
200.4	0.019547	21.756	2.770054	8.93E-05
200.5	0.019631	21.952	2.795009	9.01E-05
200.6	0.019701	22.148	2.819964	9.08E-05
200.7	0.019808	22.344	2.84492	9.19E-05
200.8	0.019898	22.54	2.869875	9.28E-05
200.9	0.019985	22.736	2.894831	9.36E-05
201	0.020047	22.932	2.919786	9.43E-05
201.1	0.020102	23.128	2.944742	9.48E-05
201.2	0.020226	23.324	2.969697	9.61E-05
201.3	0.020296	23.52	2.994653	9.67E-05

201.4	0.02035	23.716	3.019608	9.73E-05
201.5	0.020432	23.912	3.044563	9.81E-05
201.6	0.020498	24.108	3.069519	9.88E-05
201.7	0.020613	24.304	3.094474	9.99E-05
201.8	0.02068	24.5	3.11943	0.000101
201.9	0.02078	24.696	3.144385	0.000102
202	0.020851	24.892	3.169341	0.000102
202.1	0.020917	25.088	3.194296	0.000103
202.2	0.020976	25.284	3.219251	0.000104
202.3	0.021044	25.48	3.244207	0.000104
202.4	0.021162	25.676	3.269162	0.000105
202.5	0.021219	25.872	3.294118	0.000106
202.6	0.021358	26.068	3.319073	0.000107
202.7	0.021421	26.264	3.344029	0.000108
202.8	0.021491	26.46	3.368984	0.000109
202.9	0.021593	26.656	3.39394	0.00011
203	0.021634	26.852	3.418895	0.00011
203.1	0.021761	27.048	3.44385	0.000111
203.2	0.021838	27.244	3.468806	0.000112
203.3	0.0219	27.44	3.493761	0.000113
203.4	0.021967	27.636	3.518717	0.000113
203.5	0.02204	27.832	3.543672	0.000114
203.6	0.022161	28.028	3.568628	0.000115
203.7	0.022236	28.224	3.593583	0.000116
203.8	0.02234	28.42	3.618538	0.000117
203.9	0.022418	28.616	3.643494	0.000118
204	0.022466	28.812	3.668449	0.000118
204.1	0.022596	29.008	3.693405	0.00012
204.2	0.022664	29.204	3.71836	0.00012
204.3	0.022688	29.4	3.743316	0.000121
204.4	0.022795	29.596	3.768271	0.000122
204.5	0.022866	29.792	3.793227	0.000122
204.6	0.022945	29.988	3.818182	0.000123
204.7	0.023016	30.184	3.843137	0.000124
204.8	0.023134	30.38	3.868093	0.000125
204.9	0.023219	30.576	3.893048	0.000126
205	0.023288	30.772	3.918004	0.000127
205.1	0.023356	30.968	3.942959	0.000127
205.2	0.023455	31.164	3.967915	0.000128
205.3	0.02355	31.36	3.99287	0.000129
205.4	0.023611	31.556	4.017826	0.00013
205.5	0.023731	31.752	4.042781	0.000131
205.6	0.023796	31.948	4.067736	0.000132
205.7	0.02384	32.144	4.092692	0.000132
205.8	0.023953	32.34	4.117647	0.000133
205.9	0.024046	32.536	4.142603	0.000134
206	0.024128	32.732	4.167558	0.000135
206.1	0.024184	32.928	4.192514	0.000136
206.2	0.024264	33.124	4.217469	0.000136
206.3	0.024343	33.32	4.242424	0.000137
206.4	0.024406	33.516	4.26738	0.000138
206.5	0.024544	33.712	4.292335	0.000139
206.6	0.024576	33.908	4.317291	0.00014
206.7	0.024641	34.104	4.342246	0.00014
206.8	0.024783	34.3	4.367202	0.000142

206.9	0.024835	34.496	4.392157	0.000142
207	0.024905	34.692	4.417113	0.000143
207.1	0.024986	34.888	4.442068	0.000144
207.2	0.025085	35.084	4.467023	0.000145
207.3	0.025198	35.28	4.491979	0.000146
207.4	0.025246	35.476	4.516934	0.000146
207.5	0.025331	35.672	4.54189	0.000147
207.6	0.025397	35.868	4.566845	0.000148
207.7	0.025542	36.064	4.591801	0.000149
207.8	0.025558	36.26	4.616756	0.000149
207.9	0.025593	36.456	4.641711	0.00015
208	0.0257	36.652	4.666667	0.000151
208.1	0.025836	36.848	4.691622	0.000152
208.2	0.025915	37.044	4.716578	0.000153
208.3	0.025976	37.24	4.741533	0.000154
208.4	0.02602	37.436	4.766489	0.000154
208.5	0.026168	37.632	4.791444	0.000155
208.6	0.026234	37.828	4.8164	0.000156
208.7	0.026315	38.024	4.841355	0.000157
208.8	0.026371	38.22	4.86631	0.000157
208.9	0.026477	38.416	4.891266	0.000159
209	0.026568	38.612	4.916221	0.000159
209.1	0.02658	38.808	4.941177	0.00016
209.2	0.026706	39.004	4.966132	0.000161
209.3	0.026833	39.2	4.991088	0.000162
209.4	0.026921	39.396	5.016043	0.000163
209.5	0.026914	39.592	5.040998	0.000163
209.6	0.026995	39.788	5.065954	0.000164
209.7	0.02706	39.984	5.090909	0.000164
209.8	0.027105	40.18	5.115865	0.000165
209.9	0.027191	40.376	5.14082	0.000166
210	0.027366	40.572	5.165776	0.000167
210.1	0.027492	40.768	5.190731	0.000169
210.2	0.027542	40.964	5.215687	0.000169
210.3	0.027623	41.16	5.240642	0.00017
210.4	0.027647	41.356	5.265597	0.00017
210.5	0.027661	41.552	5.290553	0.00017
210.6	0.027823	41.748	5.315508	0.000172
210.7	0.027982	41.944	5.340464	0.000174
210.8	0.028035	42.14	5.365419	0.000174
210.9	0.028053	42.336	5.390375	0.000174
211	0.028116	42.532	5.41533	0.000175
211.1	0.028215	42.728	5.440285	0.000176
211.2	0.028407	42.924	5.465241	0.000178
211.3	0.028478	43.12	5.490196	0.000179
211.4	0.028507	43.316	5.515152	0.000179
211.5	0.028605	43.512	5.540107	0.00018
211.6	0.02871	43.708	5.565063	0.000181
211.7	0.028801	43.904	5.590018	0.000182
211.8	0.028811	44.1	5.614974	0.000182
211.9	0.028852	44.296	5.639929	0.000182
212	0.02892	44.492	5.664884	0.000183
212.1	0.029123	44.688	5.68984	0.000185
212.2	0.02919	44.884	5.714795	0.000186
212.3	0.029169	45.08	5.739751	0.000185

212.4	0.029219	45.276	5.764706	0.000186
212.5	0.029423	45.472	5.789662	0.000188
212.6	0.029578	45.668	5.814617	0.00019
212.7	0.029512	45.864	5.839572	0.000189
212.8	0.029566	46.06	5.864528	0.000189
212.9	0.029733	46.256	5.889483	0.000191
213	0.029876	46.452	5.914439	0.000193
213.1	0.029942	46.648	5.939394	0.000193
213.2	0.029917	46.844	5.96435	0.000193
213.3	0.030018	47.04	5.989305	0.000194
213.4	0.030083	47.236	6.014261	0.000195
213.5	0.030218	47.432	6.039216	0.000196
213.6	0.03039	47.628	6.064171	0.000198
213.7	0.030481	47.824	6.089127	0.000199
213.8	0.030408	48.02	6.114082	0.000198
213.9	0.030525	48.216	6.139038	0.000199
214	0.030596	48.412	6.163993	0.0002
214.1	0.030586	48.608	6.188949	0.0002
214.2	0.030761	48.804	6.213904	0.000201
214.3	0.030837	49	6.238859	0.000202
214.4	0.030979	49.196	6.263815	0.000204
214.5	0.031103	49.392	6.28877	0.000205
214.6	0.03115	49.588	6.313726	0.000205
214.7	0.031156	49.784	6.338681	0.000205
214.8	0.031248	49.98	6.363637	0.000206
214.9	0.031369	50.176	6.388592	0.000207
215	0.031497	50.372	6.413548	0.000209
215.1	0.031605	50.568	6.438503	0.00021
215.2	0.031594	50.764	6.463458	0.00021
215.3	0.031566	50.96	6.488414	0.000209
215.4	0.031745	51.156	6.513369	0.000211
215.5	0.031917	51.352	6.538325	0.000213
215.6	0.031998	51.548	6.56328	0.000214
215.7	0.031942	51.744	6.588236	0.000213
215.8	0.032006	51.94	6.613191	0.000214
215.9	0.032156	52.136	6.638146	0.000215
216	0.032277	52.332	6.663102	0.000217
216.1	0.032379	52.528	6.688057	0.000218
216.2	0.032495	52.724	6.713013	0.000219
216.3	0.032555	52.92	6.737968	0.000219
216.4	0.032668	53.116	6.762924	0.00022
216.5	0.032661	53.312	6.787879	0.00022
216.6	0.032669	53.508	6.812835	0.00022
216.7	0.032785	53.704	6.83779	0.000222
216.8	0.032943	53.9	6.862745	0.000223
216.9	0.03303	54.096	6.887701	0.000224
217	0.032978	54.292	6.912656	0.000224
217.1	0.03309	54.488	6.937612	0.000225
217.2	0.033231	54.684	6.962567	0.000226
217.3	0.033341	54.88	6.987523	0.000227
217.4	0.033425	55.076	7.012478	0.000228
217.5	0.033502	55.272	7.037433	0.000229
217.6	0.033598	55.468	7.062389	0.00023
217.7	0.033628	55.664	7.087344	0.00023
217.8	0.033781	55.86	7.1123	0.000232

217.9	0.033865	56.056	7.137255	0.000232
218	0.033912	56.252	7.162211	0.000233
218.1	0.033981	56.448	7.187166	0.000234
218.2	0.034093	56.644	7.212122	0.000235
218.3	0.034177	56.84	7.237077	0.000236
218.4	0.034156	57.036	7.262032	0.000235
218.5	0.034296	57.232	7.286988	0.000237
218.6	0.034359	57.428	7.311943	0.000237
218.7	0.034344	57.624	7.336899	0.000237
218.8	0.0345	57.82	7.361854	0.000239
218.9	0.03463	58.016	7.38681	0.00024
219	0.034755	58.212	7.411765	0.000241
219.1	0.034869	58.408	7.43672	0.000242
219.2	0.034815	58.604	7.461676	0.000242
219.3	0.034865	58.8	7.486631	0.000242
219.4	0.035015	58.996	7.511587	0.000244
219.5	0.035067	59.192	7.536542	0.000244
219.6	0.035189	59.388	7.561498	0.000246
219.7	0.035219	59.584	7.586453	0.000246
219.8	0.035308	59.78	7.611409	0.000247
219.9	0.035428	59.976	7.636364	0.000248
220	0.035569	60.172	7.661319	0.000249
220.1	0.035551	60.368	7.686275	0.000249
220.2	0.035624	60.564	7.71123	0.00025
220.3	0.03571	60.76	7.736186	0.000251
220.4	0.035817	60.956	7.761141	0.000252
220.5	0.035873	61.152	7.786097	0.000253
220.6	0.035961	61.348	7.811052	0.000253
220.7	0.036042	61.544	7.836008	0.000254
220.8	0.036139	61.74	7.860963	0.000255
220.9	0.036173	61.936	7.885918	0.000256
221	0.036265	62.132	7.910874	0.000256
221.1	0.036345	62.328	7.935829	0.000257
221.2	0.036458	62.524	7.960785	0.000258
221.3	0.036567	62.72	7.98574	0.000259
221.4	0.036693	62.916	8.010696	0.000261
221.5	0.036741	63.112	8.035651	0.000261
221.6	0.036818	63.308	8.060606	0.000262
221.7	0.036869	63.504	8.085562	0.000262
221.8	0.036953	63.7	8.110517	0.000263
221.9	0.037094	63.896	8.135473	0.000265
222	0.037145	64.092	8.160428	0.000265
222.1	0.03716	64.288	8.185384	0.000265
222.2	0.037265	64.484	8.210339	0.000266
222.3	0.037394	64.68	8.235295	0.000268
222.4	0.037463	64.876	8.26025	0.000268
222.5	0.03744	65.072	8.285205	0.000268
222.6	0.037568	65.268	8.310161	0.000269
222.7	0.037731	65.464	8.335116	0.000271
222.8	0.037771	65.66	8.360072	0.000271
222.9	0.037791	65.856	8.385027	0.000272
223	0.037909	66.052	8.409983	0.000273
223.1	0.038065	66.248	8.434938	0.000274
223.2	0.038098	66.444	8.459893	0.000275
223.3	0.038122	66.64	8.484849	0.000275

223.4	0.038257	66.836	8.509804	0.000276
223.5	0.038307	67.032	8.53476	0.000277
223.6	0.03842	67.228	8.559715	0.000278
223.7	0.038524	67.424	8.584671	0.000279
223.8	0.038581	67.62	8.609626	0.00028
223.9	0.038624	67.816	8.634582	0.00028
224	0.038719	68.012	8.659537	0.000281
224.1	0.03883	68.208	8.684492	0.000282
224.2	0.038841	68.404	8.709448	0.000282
224.3	0.038971	68.6	8.734403	0.000284
224.4	0.039058	68.796	8.759359	0.000284
224.5	0.039131	68.992	8.784314	0.000285
224.6	0.039241	69.188	8.80927	0.000286
224.7	0.039309	69.384	8.834225	0.000287
224.8	0.039374	69.58	8.85918	0.000288
224.9	0.039502	69.776	8.884136	0.000289
225	0.039604	69.972	8.909091	0.00029
225.1	0.039618	70.168	8.934047	0.00029
225.2	0.039682	70.364	8.959002	0.000291
225.3	0.039839	70.56	8.983958	0.000292
225.4	0.039889	70.756	9.008913	0.000293
225.5	0.039924	70.952	9.033869	0.000293
225.6	0.040047	71.148	9.058824	0.000294
225.7	0.040148	71.344	9.083779	0.000295
225.8	0.040178	71.54	9.108735	0.000296
225.9	0.040331	71.736	9.13369	0.000297
226	0.040421	71.932	9.158646	0.000298
226.1	0.040437	72.128	9.183601	0.000298
226.2	0.04053	72.324	9.208557	0.000299
226.3	0.040648	72.52	9.233512	0.0003
226.4	0.040629	72.716	9.258467	0.0003
226.5	0.040768	72.912	9.283423	0.000301
226.6	0.040899	73.108	9.308378	0.000303
226.7	0.040929	73.304	9.333334	0.000303
226.8	0.041041	73.5	9.358289	0.000304
226.9	0.041081	73.696	9.383245	0.000305
227	0.041124	73.892	9.4082	0.000305
227.1	0.041233	74.088	9.433156	0.000306
227.2	0.041327	74.284	9.458111	0.000307
227.3	0.041394	74.48	9.483066	0.000308
227.4	0.041452	74.676	9.508022	0.000308
227.5	0.041549	74.872	9.532977	0.000309
227.6	0.04163	75.068	9.557933	0.00031
227.7	0.041729	75.264	9.582888	0.000311
227.8	0.04185	75.46	9.607844	0.000312
227.9	0.041882	75.656	9.632799	0.000313
228	0.041992	75.852	9.657754	0.000314
228.1	0.042112	76.048	9.68271	0.000315
228.2	0.042149	76.244	9.707665	0.000315
228.3	0.042229	76.44	9.732621	0.000316
228.4	0.042344	76.636	9.757576	0.000317
228.5	0.042377	76.832	9.782532	0.000318
228.6	0.042449	77.028	9.807487	0.000318
228.7	0.042579	77.224	9.832443	0.00032
228.8	0.042631	77.42	9.857398	0.00032

228.9	0.042741	77.616	9.882353	0.000321
229	0.042816	77.812	9.907309	0.000322
229.1	0.042885	78.008	9.932264	0.000323
229.2	0.042974	78.204	9.95722	0.000324
229.3	0.043065	78.4	9.982175	0.000324
229.4	0.043135	78.596	10.00713	0.000325
229.5	0.043189	78.792	10.03209	0.000326
229.6	0.04327	78.988	10.05704	0.000326
229.7	0.043351	79.184	10.082	0.000327
229.8	0.043454	79.38	10.10695	0.000328
229.9	0.043512	79.576	10.13191	0.000329
230	0.043577	79.772	10.15686	0.00033
230.1	0.043658	79.968	10.18182	0.00033
230.2	0.043712	80.164	10.20677	0.000331
230.3	0.04381	80.36	10.23173	0.000332
230.4	0.043869	80.556	10.25668	0.000332
230.5	0.04397	80.752	10.28164	0.000333
230.6	0.044088	80.948	10.3066	0.000335
230.7	0.044145	81.144	10.33155	0.000335
230.8	0.044206	81.34	10.35651	0.000336
230.9	0.044284	81.536	10.38146	0.000337
231	0.044377	81.732	10.40642	0.000338
231.1	0.044462	81.928	10.43137	0.000338
231.2	0.044564	82.124	10.45633	0.000339
231.3	0.044609	82.32	10.48128	0.00034
231.4	0.044664	82.516	10.50624	0.00034
231.5	0.044795	82.712	10.53119	0.000342
231.6	0.044918	82.908	10.55615	0.000343
231.7	0.044937	83.104	10.58111	0.000343
231.8	0.045021	83.3	10.60606	0.000344
231.9	0.045125	83.496	10.63102	0.000345
232	0.045182	83.692	10.65597	0.000346
232.1	0.045268	83.888	10.68093	0.000346
232.2	0.045357	84.084	10.70588	0.000347
232.3	0.045431	84.28	10.73084	0.000348
232.4	0.045496	84.476	10.75579	0.000349
232.5	0.045582	84.672	10.78075	0.00035
232.6	0.045668	84.868	10.8057	0.00035
232.7	0.045733	85.064	10.83066	0.000351
232.8	0.045792	85.26	10.85562	0.000352
232.9	0.045897	85.456	10.88057	0.000353
233	0.046018	85.652	10.90553	0.000354
233.1	0.046111	85.848	10.93048	0.000355
233.2	0.046155	86.044	10.95544	0.000355
233.3	0.046213	86.24	10.98039	0.000356
233.4	0.046321	86.436	11.00535	0.000357
233.5	0.046418	86.632	11.0303	0.000358
233.6	0.046492	86.828	11.05526	0.000359
233.7	0.046552	87.024	11.08021	0.000359
233.8	0.046644	87.22	11.10517	0.00036
233.9	0.046731	87.416	11.13013	0.000361
234	0.046808	87.612	11.15508	0.000362
234.1	0.046929	87.808	11.18004	0.000363
234.2	0.046987	88.004	11.20499	0.000364
234.3	0.047042	88.2	11.22995	0.000364

234.4	0.047139	88.396	11.2549	0.000365
234.5	0.047237	88.592	11.27986	0.000366
234.6	0.047298	88.788	11.30481	0.000367
234.7	0.047413	88.984	11.32977	0.000368
234.8	0.047498	89.18	11.35472	0.000369
234.9	0.047516	89.376	11.37968	0.000369
235	0.047616	89.572	11.40464	0.00037
235.1	0.047713	89.768	11.42959	0.000371
235.2	0.047781	89.964	11.45455	0.000372
235.3	0.047792	90.16	11.4795	0.000372
235.4	0.047914	90.356	11.50446	0.000373
235.5	0.048024	90.552	11.52941	0.000374
235.6	0.04805	90.748	11.55437	0.000374
235.7	0.048152	90.944	11.57932	0.000375
235.8	0.04821	91.14	11.60428	0.000376
235.9	0.048288	91.336	11.62923	0.000377
236	0.04837	91.532	11.65419	0.000377
236.1	0.048452	91.728	11.67914	0.000378
236.2	0.048553	91.924	11.7041	0.000379
236.3	0.04864	92.12	11.72906	0.00038
236.4	0.048764	92.316	11.75401	0.000381
236.5	0.048833	92.512	11.77897	0.000382
236.6	0.048878	92.708	11.80392	0.000383
236.7	0.048992	92.904	11.82888	0.000384
236.8	0.049074	93.1	11.85383	0.000385
236.9	0.049199	93.296	11.87879	0.000386
237	0.04926	93.492	11.90374	0.000386
237.1	0.049333	93.688	11.9287	0.000387
237.2	0.04942	93.884	11.95365	0.000388
237.3	0.049493	94.08	11.97861	0.000389
237.4	0.049567	94.276	12.00357	0.000389
237.5	0.049646	94.472	12.02852	0.00039
237.6	0.049762	94.668	12.05348	0.000391
237.7	0.049816	94.864	12.07843	0.000392
237.8	0.049864	95.06	12.10339	0.000392
237.9	0.049939	95.256	12.12834	0.000393
238	0.05001	95.452	12.1533	0.000394
238.1	0.050094	95.648	12.17825	0.000395
238.2	0.050198	95.844	12.20321	0.000396
238.3	0.050267	96.04	12.22816	0.000396
238.4	0.050339	96.236	12.25312	0.000397
238.5	0.050414	96.432	12.27808	0.000398
238.6	0.050502	96.628	12.30303	0.000399
238.7	0.050573	96.824	12.32799	0.0004
238.8	0.050651	97.02	12.35294	0.0004
238.9	0.050748	97.216	12.3779	0.000401
239	0.05082	97.412	12.40285	0.000402
239.1	0.050907	97.608	12.42781	0.000403
239.2	0.050971	97.804	12.45276	0.000404
239.3	0.0511	98	12.47772	0.000405
239.4	0.051142	98.196	12.50267	0.000405
239.5	0.051185	98.392	12.52763	0.000406
239.6	0.051305	98.588	12.55259	0.000407
239.7	0.051397	98.784	12.57754	0.000408
239.8	0.051505	98.98	12.6025	0.000409

239.9	0.051535	99.176	12.62745	0.000409
240	0.05163	99.372	12.65241	0.00041
240.1	0.051711	99.568	12.67736	0.000411
240.2	0.051776	99.764	12.70232	0.000412
240.3	0.051867	99.96	12.72727	0.000412
240.4	0.051927	100.156	12.75223	0.000413
240.5	0.052027	100.352	12.77718	0.000414
240.6	0.052078	100.548	12.80214	0.000415
240.7	0.052163	100.744	12.8271	0.000415
240.8	0.052246	100.94	12.85205	0.000416
240.9	0.052317	101.136	12.87701	0.000417
241	0.052425	101.332	12.90196	0.000418
241.1	0.052461	101.528	12.92692	0.000418
241.2	0.052566	101.724	12.95187	0.000419
241.3	0.05265	101.92	12.97683	0.00042
241.4	0.052719	102.116	13.00178	0.000421
241.5	0.052798	102.312	13.02674	0.000422
241.6	0.052849	102.508	13.05169	0.000422
241.7	0.05294	102.704	13.07665	0.000423
241.8	0.053004	102.9	13.1016	0.000424
241.9	0.053092	103.096	13.12656	0.000425
242	0.053154	103.292	13.15152	0.000425
242.1	0.053251	103.488	13.17647	0.000426
242.2	0.053358	103.684	13.20143	0.000427
242.3	0.05338	103.88	13.22638	0.000428
242.4	0.053495	104.076	13.25134	0.000429
242.5	0.053561	104.272	13.27629	0.000429
242.6	0.053647	104.468	13.30125	0.00043
242.7	0.053722	104.664	13.3262	0.000431
242.8	0.053778	104.86	13.35116	0.000432
242.9	0.053935	105.056	13.37611	0.000433
243	0.054015	105.252	13.40107	0.000434
243.1	0.054004	105.448	13.42603	0.000434
243.2	0.054114	105.644	13.45098	0.000435
243.3	0.0542	105.84	13.47594	0.000436
243.4	0.054275	106.036	13.50089	0.000437
243.5	0.054342	106.232	13.52585	0.000437
243.6	0.054448	106.428	13.5508	0.000438
243.7	0.054498	106.624	13.57576	0.000439
243.8	0.054595	106.82	13.60071	0.00044
243.9	0.05466	107.016	13.62567	0.00044
244	0.054713	107.212	13.65062	0.000441
244.1	0.054829	107.408	13.67558	0.000442
244.2	0.054941	107.604	13.70054	0.000443
244.3	0.055002	107.8	13.72549	0.000444
244.4	0.055098	107.996	13.75045	0.000445
244.5	0.055165	108.192	13.7754	0.000445
244.6	0.055273	108.388	13.80036	0.000447
244.7	0.055324	108.584	13.82531	0.000447
244.8	0.055398	108.78	13.85027	0.000448
244.9	0.055491	108.976	13.87522	0.000449
245	0.05558	109.172	13.90018	0.00045
245.1	0.055658	109.368	13.92513	0.00045
245.2	0.055708	109.564	13.95009	0.000451
245.3	0.055797	109.76	13.97505	0.000452

245.4	0.055869	109.956	14	0.000452
245.5	0.055966	110.152	14.02496	0.000453
245.6	0.056053	110.348	14.04991	0.000454
245.7	0.056089	110.544	14.07487	0.000455
245.8	0.056194	110.74	14.09982	0.000456
245.9	0.056246	110.936	14.12478	0.000456
246	0.056349	111.132	14.14973	0.000457
246.1	0.056413	111.328	14.17469	0.000458
246.2	0.056514	111.524	14.19964	0.000459
246.3	0.056585	111.72	14.2246	0.00046
246.4	0.056639	111.916	14.24956	0.00046
246.5	0.05674	112.112	14.27451	0.000461
246.6	0.056853	112.308	14.29947	0.000462
246.7	0.056904	112.504	14.32442	0.000463
246.8	0.056988	112.7	14.34938	0.000464
246.9	0.057084	112.896	14.37433	0.000465
247	0.05714	113.092	14.39929	0.000465
247.1	0.057195	113.288	14.42424	0.000466
247.2	0.057345	113.484	14.4492	0.000467
247.3	0.057397	113.68	14.47415	0.000468
247.4	0.057453	113.876	14.49911	0.000468
247.5	0.057545	114.072	14.52406	0.000469
247.6	0.05761	114.268	14.54902	0.00047
247.7	0.057695	114.464	14.57398	0.000471
247.8	0.057788	114.66	14.59893	0.000472
247.9	0.05788	114.856	14.62389	0.000473
248	0.05793	115.052	14.64884	0.000473
248.1	0.058004	115.248	14.6738	0.000474
248.2	0.058111	115.444	14.69875	0.000475
248.3	0.058145	115.64	14.72371	0.000475
248.4	0.058224	115.836	14.74866	0.000476
248.5	0.058328	116.032	14.77362	0.000477
248.6	0.058427	116.228	14.79857	0.000478

B.1.7 Elastic Modulus test results of SFRGC(Na) at 200ºC temperature.

Time	Absolute	Force	Stress	Strain
419.4	0.031791	0	0	0
419.5	0.031994	0.196	0.024955	2.03E-06
419.6	0.032024	0.392	0.049911	2.33E-06
419.7	0.032088	0.588	0.074866	2.97E-06
419.8	0.032226	0.784	0.099822	4.36E-06
419.9	0.032332	0.98	0.124777	5.41E-06
420	0.032456	1.176	0.149733	6.65E-06
420.1	0.032492	1.372	0.174688	7.01E-06
420.2	0.032645	1.568	0.199644	8.55E-06
420.3	0.032734	1.764	0.224599	9.43E-06
420.4	0.032892	1.96	0.249554	1.1E-05

420.5	0.032972	2.156	0.27451	1.18E-05
420.6	0.033025	2.352	0.299465	1.23E-05
420.7	0.033138	2.548	0.324421	1.35E-05
420.8	0.033233	2.744	0.349376	1.44E-05
420.9	0.033423	2.94	0.374332	1.63E-05
421	0.033447	3.136	0.399287	1.66E-05
421.1	0.033564	3.332	0.424242	1.77E-05
421.2	0.033671	3.528	0.449198	1.88E-05
421.3	0.033859	3.724	0.474153	2.07E-05
421.4	0.033936	3.92	0.499109	2.14E-05
421.5	0.033991	4.116	0.524064	2.2E-05
421.6	0.034116	4.312	0.54902	2.32E-05
421.7	0.034213	4.508	0.573975	2.42E-05
421.8	0.0344	4.704	0.598931	2.61E-05
421.9	0.034401	4.9	0.623886	2.61E-05
422	0.034491	5.096	0.648841	2.7E-05
422.1	0.034619	5.292	0.673797	2.83E-05
422.2	0.034768	5.488	0.698752	2.98E-05
422.3	0.034885	5.684	0.723708	3.09E-05
422.4	0.034908	5.88	0.748663	3.12E-05
422.5	0.035033	6.076	0.773619	3.24E-05
422.6	0.035126	6.272	0.798574	3.33E-05
422.7	0.035308	6.468	0.823529	3.52E-05
422.8	0.035355	6.664	0.848485	3.56E-05
422.9	0.035462	6.86	0.87344	3.67E-05
423	0.035569	7.056	0.898396	3.78E-05
423.1	0.035763	7.252	0.923351	3.97E-05
423.2	0.035848	7.448	0.948307	4.06E-05
423.3	0.035892	7.644	0.973262	4.1E-05
423.4	0.035981	7.84	0.998218	4.19E-05
423.5	0.036079	8.036	1.023173	4.29E-05
423.6	0.036311	8.232	1.048128	4.52E-05
423.7	0.036281	8.428	1.073084	4.49E-05
423.8	0.036408	8.624	1.098039	4.62E-05
423.9	0.036518	8.82	1.122995	4.73E-05
424	0.036669	9.016	1.14795	4.88E-05
424.1	0.036748	9.212	1.172906	4.96E-05
424.2	0.036842	9.408	1.197861	5.05E-05
424.3	0.036981	9.604	1.222816	5.19E-05
424.4	0.037014	9.8	1.247772	5.22E-05
424.5	0.037165	9.996	1.272727	5.37E-05
424.6	0.037268	10.192	1.297683	5.48E-05
424.7	0.037386	10.388	1.322638	5.6E-05
424.8	0.037447	10.584	1.347594	5.66E-05
424.9	0.037612	10.78	1.372549	5.82E-05
425	0.037692	10.976	1.397505	5.9E-05
425.1	0.037799	11.172	1.42246	6.01E-05
425.2	0.03791	11.368	1.447415	6.12E-05
425.3	0.037954	11.564	1.472371	6.16E-05
425.4	0.0381	11.76	1.497326	6.31E-05
425.5	0.038172	11.956	1.522282	6.38E-05
425.6	0.038311	12.152	1.547237	6.52E-05
425.7	0.038399	12.348	1.572193	6.61E-05
425.8	0.038583	12.544	1.597148	6.79E-05
425.9	0.038628	12.74	1.622103	6.84E-05

426	0.038711	12.936	1.647059	6.92E-05
426.1	0.038814	13.132	1.672014	7.02E-05
426.2	0.038932	13.328	1.69697	7.14E-05
426.3	0.039123	13.524	1.721925	7.33E-05
426.4	0.039188	13.72	1.746881	7.4E-05
426.5	0.039219	13.916	1.771836	7.43E-05
426.6	0.039279	14.112	1.796792	7.49E-05
426.7	0.039475	14.308	1.821747	7.68E-05
426.8	0.039556	14.504	1.846702	7.76E-05
426.9	0.039661	14.7	1.871658	7.87E-05
427	0.039701	14.896	1.896613	7.91E-05
427.1	0.039854	15.092	1.921569	8.06E-05
427.2	0.039968	15.288	1.946524	8.18E-05
427.3	0.040051	15.484	1.97148	8.26E-05
427.4	0.040141	15.68	1.996435	8.35E-05
427.5	0.040276	15.876	2.02139	8.49E-05
427.6	0.040429	16.072	2.046346	8.64E-05
427.7	0.040436	16.268	2.071301	8.65E-05
427.8	0.04055	16.464	2.096257	8.76E-05
427.9	0.040632	16.66	2.121212	8.84E-05
428	0.040805	16.856	2.146168	9.01E-05
428.1	0.040852	17.052	2.171123	9.06E-05
428.2	0.040966	17.248	2.196079	9.17E-05
428.3	0.041042	17.444	2.221034	9.25E-05
428.4	0.0412	17.64	2.245989	9.41E-05
428.5	0.041324	17.836	2.270945	9.53E-05
428.6	0.041367	18.032	2.2959	9.58E-05
428.7	0.041478	18.228	2.320856	9.69E-05
428.8	0.04157	18.424	2.345811	9.78E-05
428.9	0.04175	18.62	2.370767	9.96E-05
429	0.041783	18.816	2.395722	9.99E-05
429.1	0.041882	19.012	2.420677	0.000101
429.2	0.042013	19.208	2.445633	0.000102
429.3	0.042177	19.404	2.470588	0.000104
429.4	0.042233	19.6	2.495544	0.000104
429.5	0.042318	19.796	2.520499	0.000105
429.6	0.042448	19.992	2.545455	0.000107
429.7	0.042541	20.188	2.57041	0.000108
429.8	0.042685	20.384	2.595366	0.000109
429.9	0.042725	20.58	2.620321	0.000109
430	0.042838	20.776	2.645276	0.00011
430.1	0.042937	20.972	2.670232	0.000111
430.2	0.043123	21.168	2.695187	0.000113
430.3	0.043134	21.364	2.720143	0.000113
430.4	0.04321	21.56	2.745098	0.000114
430.5	0.043329	21.756	2.770054	0.000115
430.6	0.043471	21.952	2.795009	0.000117
430.7	0.043553	22.148	2.819964	0.000118
430.8	0.043641	22.344	2.84492	0.000119
430.9	0.043746	22.54	2.869875	0.00012
431	0.043821	22.736	2.894831	0.00012
431.1	0.044019	22.932	2.919786	0.000122
431.2	0.044053	23.128	2.944742	0.000123
431.3	0.044139	23.324	2.969697	0.000123
431.4	0.044232	23.52	2.994653	0.000124

431.5	0.044432	23.716	3.019608	0.000126
431.6	0.044472	23.912	3.044563	0.000127
431.7	0.044561	24.108	3.069519	0.000128
431.8	0.044667	24.304	3.094474	0.000129
431.9	0.044798	24.5	3.11943	0.00013
432	0.044916	24.696	3.144385	0.000131
432.1	0.044963	24.892	3.169341	0.000132
432.2	0.045084	25.088	3.194296	0.000133
432.3	0.04517	25.284	3.219251	0.000134
432.4	0.045349	25.48	3.244207	0.000136
432.5	0.045356	25.676	3.269162	0.000136
432.6	0.045462	25.872	3.294118	0.000137
432.7	0.045591	26.068	3.319073	0.000138
432.8	0.045767	26.264	3.344029	0.00014
432.9	0.045829	26.46	3.368984	0.00014
433	0.045879	26.656	3.39394	0.000141
433.1	0.045996	26.852	3.418895	0.000142
433.2	0.046116	27.048	3.44385	0.000143
433.3	0.046236	27.244	3.468806	0.000144
433.4	0.04628	27.44	3.493761	0.000145
433.5	0.046394	27.636	3.518717	0.000146
433.6	0.04647	27.832	3.543672	0.000147
433.7	0.046622	28.028	3.568628	0.000148
433.8	0.046686	28.224	3.593583	0.000149
433.9	0.046812	28.42	3.618538	0.00015
434	0.046887	28.616	3.643494	0.000151
434.1	0.04706	28.812	3.668449	0.000153
434.2	0.047093	29.008	3.693405	0.000153
434.3	0.047177	29.204	3.71836	0.000154
434.4	0.04728	29.4	3.743316	0.000155
434.5	0.047419	29.596	3.768271	0.000156
434.6	0.047485	29.792	3.793227	0.000157
434.7	0.047555	29.988	3.818182	0.000158
434.8	0.047668	30.184	3.843137	0.000159
434.9	0.047765	30.38	3.868093	0.00016
435	0.047932	30.576	3.893048	0.000161
435.1	0.047965	30.772	3.918004	0.000162
435.2	0.048079	30.968	3.942959	0.000163
435.3	0.048176	31.164	3.967915	0.000164
435.4	0.048315	31.36	3.99287	0.000165
435.5	0.048372	31.556	4.017826	0.000166
435.6	0.048484	31.752	4.042781	0.000167
435.7	0.048537	31.948	4.067736	0.000167
435.8	0.048698	32.144	4.092692	0.000169
435.9	0.048775	32.34	4.117647	0.00017
436	0.048875	32.536	4.142603	0.000171
436.1	0.048972	32.732	4.167558	0.000172
436.2	0.049099	32.928	4.192514	0.000173
436.3	0.049156	33.124	4.217469	0.000174
436.4	0.049248	33.32	4.242424	0.000175
436.5	0.049347	33.516	4.26738	0.000176
436.6	0.049427	33.712	4.292335	0.000176
436.7	0.049555	33.908	4.317291	0.000178
436.8	0.049631	34.104	4.342246	0.000178
436.9	0.049736	34.3	4.367202	0.000179

437	0.049817	34.496	4.392157	0.00018
437.1	0.050017	34.692	4.417113	0.000182
437.2	0.05004	34.888	4.442068	0.000182
437.3	0.050153	35.084	4.467023	0.000184
437.4	0.050225	35.28	4.491979	0.000184
437.5	0.050371	35.476	4.516934	0.000186
437.6	0.050446	35.672	4.54189	0.000187
437.7	0.05054	35.868	4.566845	0.000187
437.8	0.050679	36.064	4.591801	0.000189
437.9	0.050782	36.26	4.616756	0.00019
438	0.050889	36.456	4.641711	0.000191
438.1	0.050986	36.652	4.666667	0.000192
438.2	0.051078	36.848	4.691622	0.000193
438.3	0.051127	37.044	4.716578	0.000193
438.4	0.051321	37.24	4.741533	0.000195
438.5	0.051355	37.436	4.766489	0.000196
438.6	0.051455	37.632	4.791444	0.000197
438.7	0.051559	37.828	4.8164	0.000198
438.8	0.051701	38.024	4.841355	0.000199
438.9	0.051735	38.22	4.86631	0.000199
439	0.051871	38.416	4.891266	0.000201
439.1	0.051983	38.612	4.916221	0.000202
439.2	0.052041	38.808	4.941177	0.000203
439.3	0.052191	39.004	4.966132	0.000204
439.4	0.052262	39.2	4.991088	0.000205
439.5	0.052387	39.396	5.016043	0.000206
439.6	0.052448	39.592	5.040998	0.000207
439.7	0.05263	39.788	5.065954	0.000208
439.8	0.052669	39.984	5.090909	0.000209
439.9	0.052766	40.18	5.115865	0.00021
440	0.052872	40.376	5.14082	0.000211
440.1	0.052986	40.572	5.165776	0.000212
440.2	0.053096	40.768	5.190731	0.000213
440.3	0.053123	40.964	5.215687	0.000213
440.4	0.053205	41.16	5.240642	0.000214
440.5	0.05331	41.356	5.265597	0.000215
440.6	0.053451	41.552	5.290553	0.000217
440.7	0.053545	41.748	5.315508	0.000218
440.8	0.053606	41.944	5.340464	0.000218
440.9	0.053746	42.14	5.365419	0.00022
441	0.053855	42.336	5.390375	0.000221
441.1	0.05398	42.532	5.41533	0.000222
441.2	0.053962	42.728	5.440285	0.000222
441.3	0.054059	42.924	5.465241	0.000223
441.4	0.054212	43.12	5.490196	0.000224
441.5	0.054384	43.316	5.515152	0.000226
441.6	0.054421	43.512	5.540107	0.000226
441.7	0.054575	43.708	5.565063	0.000228
441.8	0.054624	43.904	5.590018	0.000228
441.9	0.054734	44.1	5.614974	0.000229
442	0.054786	44.296	5.639929	0.00023
442.1	0.054872	44.492	5.664884	0.000231
442.2	0.055007	44.688	5.68984	0.000232
442.3	0.055157	44.884	5.714795	0.000234
442.4	0.05527	45.08	5.739751	0.000235

442.5	0.055308	45.276	5.764706	0.000235
442.6	0.055439	45.472	5.789662	0.000236
442.7	0.055459	45.668	5.814617	0.000237
442.8	0.055575	45.864	5.839572	0.000238
442.9	0.055653	46.06	5.864528	0.000239
443	0.05568	46.256	5.889483	0.000239
443.1	0.055852	46.452	5.914439	0.000241
443.2	0.05607	46.648	5.939394	0.000243
443.3	0.056181	46.844	5.96435	0.000244
443.4	0.056186	47.04	5.989305	0.000244
443.5	0.056214	47.236	6.014261	0.000244
443.6	0.056263	47.432	6.039216	0.000245
443.7	0.056562	47.628	6.064171	0.000248
443.8	0.056688	47.824	6.089127	0.000249
443.9	0.056723	48.02	6.114082	0.000249
444	0.056858	48.216	6.139038	0.000251
444.1	0.056897	48.412	6.163993	0.000251
444.2	0.056964	48.608	6.188949	0.000252
444.3	0.056987	48.804	6.213904	0.000252
444.4	0.057182	49	6.238859	0.000254
444.5	0.057334	49.196	6.263815	0.000255
444.6	0.057452	49.392	6.28877	0.000257
444.7	0.057554	49.588	6.313726	0.000258
444.8	0.057611	49.784	6.338681	0.000258
444.9	0.057681	49.98	6.363637	0.000259
445	0.057866	50.176	6.388592	0.000261
445.1	0.057961	50.372	6.413548	0.000262
445.2	0.057946	50.568	6.438503	0.000262
445.3	0.058058	50.764	6.463458	0.000263
445.4	0.058117	50.96	6.488414	0.000263
445.5	0.058216	51.156	6.513369	0.000264
445.6	0.05834	51.352	6.538325	0.000265
445.7	0.058546	51.548	6.56328	0.000268
445.8	0.058567	51.744	6.588236	0.000268
445.9	0.058742	51.94	6.613191	0.00027
446	0.058745	52.136	6.638146	0.00027
446.1	0.058748	52.332	6.663102	0.00027
446.2	0.058914	52.528	6.688057	0.000271
446.3	0.05911	52.724	6.713013	0.000273
446.4	0.059156	52.92	6.737968	0.000274
446.5	0.059153	53.116	6.762924	0.000274
446.6	0.059288	53.312	6.787879	0.000275
446.7	0.059385	53.508	6.812835	0.000276
446.8	0.059555	53.704	6.83779	0.000278
446.9	0.059581	53.9	6.862745	0.000278
447	0.059696	54.096	6.887701	0.000279
447.1	0.059831	54.292	6.912656	0.00028
447.2	0.059934	54.488	6.937612	0.000281
447.3	0.059901	54.684	6.962567	0.000281
447.4	0.06006	54.88	6.987523	0.000283
447.5	0.060219	55.076	7.012478	0.000284
447.6	0.060311	55.272	7.037433	0.000285
447.7	0.060498	55.468	7.062389	0.000287
447.8	0.060444	55.664	7.087344	0.000287
447.9	0.060487	55.86	7.1123	0.000287

448	0.060566	56.056	7.137255	0.000288
448.1	0.06086	56.252	7.162211	0.000291
448.2	0.060884	56.448	7.187166	0.000291
448.3	0.060876	56.644	7.212122	0.000291
448.4	0.06095	56.84	7.237077	0.000292
448.5	0.061174	57.036	7.262032	0.000294
448.6	0.061331	57.232	7.286988	0.000295
448.7	0.061294	57.428	7.311943	0.000295
448.8	0.061351	57.624	7.336899	0.000296
448.9	0.061564	57.82	7.361854	0.000298
449	0.061756	58.016	7.38681	0.0003
449.1	0.061741	58.212	7.411765	0.0003
449.2	0.06174	58.408	7.43672	0.000299
449.3	0.061849	58.604	7.461676	0.000301
449.4	0.0621	58.8	7.486631	0.000303
449.5	0.062125	58.996	7.511587	0.000303
449.6	0.062243	59.192	7.536542	0.000305
449.7	0.062241	59.388	7.561498	0.000305
449.8	0.062332	59.584	7.586453	0.000305
449.9	0.062514	59.78	7.611409	0.000307
450	0.062556	59.976	7.636364	0.000308
450.1	0.062589	60.172	7.661319	0.000308
450.2	0.062632	60.368	7.686275	0.000308
450.3	0.062849	60.564	7.71123	0.000311
450.4	0.062816	60.76	7.736186	0.00031
450.5	0.062899	60.956	7.761141	0.000311
450.6	0.06307	61.152	7.786097	0.000313
450.7	0.063241	61.348	7.811052	0.000315
450.8	0.063285	61.544	7.836008	0.000315
450.9	0.063349	61.74	7.860963	0.000316
451	0.063484	61.936	7.885918	0.000317
451.1	0.063592	62.132	7.910874	0.000318
451.2	0.063581	62.328	7.935829	0.000318
451.3	0.063663	62.524	7.960785	0.000319
451.4	0.06377	62.72	7.98574	0.00032
451.5	0.063852	62.916	8.010696	0.000321
451.6	0.064104	63.112	8.035651	0.000323
451.7	0.064165	63.308	8.060606	0.000324
451.8	0.064253	63.504	8.085562	0.000325
451.9	0.064223	63.7	8.110517	0.000324
452	0.064427	63.896	8.135473	0.000326
452.1	0.064464	64.092	8.160428	0.000327
452.2	0.064558	64.288	8.185384	0.000328
452.3	0.064762	64.484	8.210339	0.00033
452.4	0.064897	64.68	8.235295	0.000331
452.5	0.064846	64.876	8.26025	0.000331
452.6	0.064887	65.072	8.285205	0.000331
452.7	0.065087	65.268	8.310161	0.000333
452.8	0.065175	65.464	8.335116	0.000334
452.9	0.065263	65.66	8.360072	0.000335
453	0.065258	65.856	8.385027	0.000335
453.1	0.065423	66.052	8.409983	0.000336
453.2	0.065548	66.248	8.434938	0.000338
453.3	0.065727	66.444	8.459893	0.000339
453.4	0.065626	66.64	8.484849	0.000338

453.5	0.065721	66.836	8.509804	0.000339
453.6	0.065809	67.032	8.53476	0.00034
453.7	0.06591	67.228	8.559715	0.000341
453.8	0.066072	67.424	8.584671	0.000343
453.9	0.06604	67.62	8.609626	0.000342
454	0.066166	67.816	8.634582	0.000344
454.1	0.066256	68.012	8.659537	0.000345
454.2	0.066447	68.208	8.684492	0.000347
454.3	0.066534	68.404	8.709448	0.000347
454.4	0.066626	68.6	8.734403	0.000348
454.5	0.066733	68.796	8.759359	0.000349
454.6	0.066908	68.992	8.784314	0.000351
454.7	0.066822	69.188	8.80927	0.00035
454.8	0.066906	69.384	8.834225	0.000351
454.9	0.067087	69.58	8.85918	0.000353
455	0.067237	69.776	8.884136	0.000354
455.1	0.067351	69.972	8.909091	0.000356
455.2	0.067242	70.168	8.934047	0.000355
455.3	0.067392	70.364	8.959002	0.000356
455.4	0.067512	70.56	8.983958	0.000357
455.5	0.067779	70.756	9.008913	0.00036
455.6	0.067814	70.952	9.033869	0.00036
455.7	0.067758	71.148	9.058824	0.00036
455.8	0.067796	71.344	9.083779	0.00036
455.9	0.06803	71.54	9.108735	0.000362
456	0.068158	71.736	9.13369	0.000364
456.1	0.068196	71.932	9.158646	0.000364
456.2	0.068157	72.128	9.183601	0.000364
456.3	0.068359	72.324	9.208557	0.000366
456.4	0.068534	72.52	9.233512	0.000367
456.5	0.068591	72.716	9.258467	0.000368
456.6	0.068582	72.912	9.283423	0.000368
456.7	0.068671	73.108	9.308378	0.000369
456.8	0.068849	73.304	9.333334	0.000371
456.9	0.06894	73.5	9.358289	0.000371
457	0.069067	73.696	9.383245	0.000373
457.1	0.069169	73.892	9.4082	0.000374
457.2	0.069243	74.088	9.433156	0.000375
457.3	0.06924	74.284	9.458111	0.000374
457.4	0.069394	74.48	9.483066	0.000376
457.5	0.069462	74.676	9.508022	0.000377
457.6	0.069604	74.872	9.532977	0.000378
457.7	0.069603	75.068	9.557933	0.000378
457.8	0.069757	75.264	9.582888	0.00038
457.9	0.069796	75.46	9.607844	0.00038
458	0.069976	75.656	9.632799	0.000382
458.1	0.070021	75.852	9.657754	0.000382
458.2	0.070132	76.048	9.68271	0.000383
458.3	0.070293	76.244	9.707665	0.000385
458.4	0.070403	76.44	9.732621	0.000386
458.5	0.070373	76.636	9.757576	0.000386
458.6	0.070434	76.832	9.782532	0.000386
458.7	0.070577	77.028	9.807487	0.000388
458.8	0.070758	77.224	9.832443	0.00039
458.9	0.070873	77.42	9.857398	0.000391

459	0.070733	77.616	9.882353	0.000389
459.1	0.070903	77.812	9.907309	0.000391
459.2	0.071099	78.008	9.932264	0.000393
459.3	0.071204	78.204	9.95722	0.000394
459.4	0.071115	78.4	9.982175	0.000393
459.5	0.07123	78.596	10.00713	0.000394
459.6	0.071357	78.792	10.03209	0.000396
459.7	0.071508	78.988	10.05704	0.000397
459.8	0.071505	79.184	10.082	0.000397
459.9	0.071534	79.38	10.10695	0.000397
460	0.071705	79.576	10.13191	0.000399
460.1	0.071779	79.772	10.15686	0.0004
460.2	0.071924	79.968	10.18182	0.000401
460.3	0.071948	80.164	10.20677	0.000402
460.4	0.072078	80.36	10.23173	0.000403
460.5	0.072127	80.556	10.25668	0.000403
460.6	0.072317	80.752	10.28164	0.000405
460.7	0.072321	80.948	10.3066	0.000405
460.8	0.072401	81.144	10.33155	0.000406
460.9	0.072519	81.34	10.35651	0.000407
461	0.072598	81.536	10.38146	0.000408
461.1	0.072708	81.732	10.40642	0.000409
461.2	0.072739	81.928	10.43137	0.000409
461.3	0.072866	82.124	10.45633	0.000411
461.4	0.072961	82.32	10.48128	0.000412
461.5	0.073107	82.516	10.50624	0.000413
461.6	0.073122	82.712	10.53119	0.000413
461.7	0.073236	82.908	10.55615	0.000414
461.8	0.07333	83.104	10.58111	0.000415
461.9	0.073435	83.3	10.60606	0.000416
462	0.073491	83.496	10.63102	0.000417
462.1	0.073565	83.692	10.65597	0.000418
462.2	0.073684	83.888	10.68093	0.000419
462.3	0.073731	84.084	10.70588	0.000419
462.4	0.073828	84.28	10.73084	0.00042
462.5	0.073932	84.476	10.75579	0.000421
462.6	0.074081	84.672	10.78075	0.000423
462.7	0.074153	84.868	10.8057	0.000424
462.8	0.074288	85.064	10.83066	0.000425
462.9	0.074283	85.26	10.85562	0.000425
463	0.07431	85.456	10.88057	0.000425
463.1	0.074455	85.652	10.90553	0.000427
463.2	0.074596	85.848	10.93048	0.000428
463.3	0.074641	86.044	10.95544	0.000428
463.4	0.074691	86.24	10.98039	0.000429
463.5	0.074816	86.436	11.00535	0.00043
463.6	0.074932	86.632	11.0303	0.000431
463.7	0.075063	86.828	11.05526	0.000433
463.8	0.075093	87.024	11.08021	0.000433
463.9	0.075158	87.22	11.10517	0.000434
464	0.075269	87.416	11.13013	0.000435
464.1	0.075363	87.612	11.15508	0.000436
464.2	0.075394	87.808	11.18004	0.000436
464.3	0.075484	88.004	11.20499	0.000437
464.4	0.075598	88.2	11.22995	0.000438

464.5	0.075767	88.396	11.2549	0.00044
464.6	0.07584	88.592	11.27986	0.00044
464.7	0.075866	88.788	11.30481	0.000441
464.8	0.075919	88.984	11.32977	0.000441
464.9	0.076067	89.18	11.35472	0.000443
465	0.076169	89.376	11.37968	0.000444
465.1	0.076202	89.572	11.40464	0.000444
465.2	0.076344	89.768	11.42959	0.000446
465.3	0.076376	89.964	11.45455	0.000446
465.4	0.076506	90.16	11.4795	0.000447
465.5	0.076553	90.356	11.50446	0.000448
465.6	0.076642	90.552	11.52941	0.000449
465.7	0.076707	90.748	11.55437	0.000449
465.8	0.076876	90.944	11.57932	0.000451
465.9	0.076954	91.14	11.60428	0.000452
466	0.077016	91.336	11.62923	0.000452
466.1	0.077055	91.532	11.65419	0.000453
466.2	0.077207	91.728	11.67914	0.000454
466.3	0.077307	91.924	11.7041	0.000455
466.4	0.077408	92.12	11.72906	0.000456
466.5	0.07753	92.316	11.75401	0.000457
466.6	0.077608	92.512	11.77897	0.000458
466.7	0.077701	92.708	11.80392	0.000459
466.8	0.077735	92.904	11.82888	0.000459
466.9	0.077838	93.1	11.85383	0.00046
467	0.077916	93.296	11.87879	0.000461
467.1	0.078068	93.492	11.90374	0.000463
467.2	0.078082	93.688	11.9287	0.000463
467.3	0.078161	93.884	11.95365	0.000464
467.4	0.078267	94.08	11.97861	0.000465
467.5	0.078323	94.276	12.00357	0.000465
467.6	0.078446	94.472	12.02852	0.000467
467.7	0.078498	94.668	12.05348	0.000467
467.8	0.078554	94.864	12.07843	0.000468
467.9	0.078548	95.06	12.10339	0.000468
468	0.078733	95.256	12.12834	0.000469
468.1	0.078822	95.452	12.1533	0.00047
468.2	0.078886	95.648	12.17825	0.000471
468.3	0.078905	95.844	12.20321	0.000471
468.4	0.079134	96.04	12.22816	0.000473
468.5	0.079251	96.236	12.25312	0.000475
468.6	0.07932	96.432	12.27808	0.000475
468.7	0.07941	96.628	12.30303	0.000476
468.8	0.079521	96.824	12.32799	0.000477
468.9	0.079595	97.02	12.35294	0.000478
469	0.079643	97.216	12.3779	0.000479
469.1	0.07974	97.412	12.40285	0.000479
469.2	0.079827	97.608	12.42781	0.00048
469.3	0.079978	97.804	12.45276	0.000482
469.4	0.07995	98	12.47772	0.000482
469.5	0.080002	98.196	12.50267	0.000482
469.6	0.080106	98.392	12.52763	0.000483
469.7	0.080239	98.588	12.55259	0.000484
469.8	0.080294	98.784	12.57754	0.000485
469.9	0.080335	98.98	12.6025	0.000485

470	0.080422	99.176	12.62745	0.000486
470.1	0.08059	99.372	12.65241	0.000488
470.2	0.080629	99.568	12.67736	0.000488
470.3	0.080679	99.764	12.70232	0.000489
470.4	0.080818	99.96	12.72727	0.00049
470.5	0.080912	100.156	12.75223	0.000491
470.6	0.080927	100.352	12.77718	0.000491
470.7	0.081	100.548	12.80214	0.000492
470.8	0.081161	100.744	12.8271	0.000494
470.9	0.081232	100.94	12.85205	0.000494
471	0.081318	101.136	12.87701	0.000495
471.1	0.081354	101.332	12.90196	0.000496
471.2	0.081442	101.528	12.92692	0.000497
471.3	0.081543	101.724	12.95187	0.000498
471.4	0.081655	101.92	12.97683	0.000499
471.5	0.081721	102.116	13.00178	0.000499
471.6	0.08183	102.312	13.02674	0.0005
471.7	0.081953	102.508	13.05169	0.000502
471.8	0.082008	102.704	13.07665	0.000502
471.9	0.082058	102.9	13.1016	0.000503
472	0.082167	103.096	13.12656	0.000504
472.1	0.082281	103.292	13.15152	0.000505
472.2	0.082324	103.488	13.17647	0.000505
472.3	0.082415	103.684	13.20143	0.000506
472.4	0.082474	103.88	13.22638	0.000507
472.5	0.082564	104.076	13.25134	0.000508
472.6	0.082634	104.272	13.27629	0.000508
472.7	0.082785	104.468	13.30125	0.00051
472.8	0.082766	104.664	13.3262	0.00051
472.9	0.082903	104.86	13.35116	0.000511
473	0.083002	105.056	13.37611	0.000512
473.1	0.083092	105.252	13.40107	0.000513
473.2	0.083152	105.448	13.42603	0.000514
473.3	0.083221	105.644	13.45098	0.000514
473.4	0.083303	105.84	13.47594	0.000515
473.5	0.083487	106.036	13.50089	0.000517
473.6	0.083498	106.232	13.52585	0.000517
473.7	0.083545	106.428	13.5508	0.000518
473.8	0.083678	106.624	13.57576	0.000519
473.9	0.083821	106.82	13.60071	0.00052
474	0.08382	107.016	13.62567	0.00052
474.1	0.083871	107.212	13.65062	0.000521
474.2	0.084066	107.408	13.67558	0.000523
474.3	0.084184	107.604	13.70054	0.000524
474.4	0.084292	107.8	13.72549	0.000525
474.5	0.084328	107.996	13.75045	0.000525
474.6	0.084399	108.192	13.7754	0.000526
474.7	0.084429	108.388	13.80036	0.000526
474.8	0.084543	108.584	13.82531	0.000528
474.9	0.084566	108.78	13.85027	0.000528
475	0.084669	108.976	13.87522	0.000529
475.1	0.084768	109.172	13.90018	0.00053
475.2	0.084871	109.368	13.92513	0.000531
475.3	0.084916	109.564	13.95009	0.000531
475.4	0.085052	109.76	13.97505	0.000533

475.5	0.085106	109.956	14	0.000533
475.6	0.085159	110.152	14.02496	0.000534
475.7	0.085262	110.348	14.04991	0.000535
475.8	0.085354	110.544	14.07487	0.000536
475.9	0.085369	110.74	14.09982	0.000536
476	0.085486	110.936	14.12478	0.000537
476.1	0.085685	111.132	14.14973	0.000539
476.2	0.085663	111.328	14.17469	0.000539
476.3	0.085707	111.524	14.19964	0.000539
476.4	0.085851	111.72	14.2246	0.000541
476.5	0.086071	111.916	14.24956	0.000543
476.6	0.086077	112.112	14.27451	0.000543
476.7	0.086145	112.308	14.29947	0.000544
476.8	0.086143	112.504	14.32442	0.000544
476.9	0.086295	112.7	14.34938	0.000545
477	0.08638	112.896	14.37433	0.000546
477.1	0.08647	113.092	14.39929	0.000547
477.2	0.086495	113.288	14.42424	0.000547
477.3	0.086645	113.484	14.4492	0.000549
477.4	0.086701	113.68	14.47415	0.000549
477.5	0.086776	113.876	14.49911	0.00055
477.6	0.086829	114.072	14.52406	0.00055
477.7	0.086944	114.268	14.54902	0.000552
477.8	0.087037	114.464	14.57398	0.000552
477.9	0.087019	114.66	14.59893	0.000552
478	0.087144	114.856	14.62389	0.000554
478.1	0.087282	115.052	14.64884	0.000555
478.2	0.087364	115.248	14.6738	0.000556
478.3	0.087415	115.444	14.69875	0.000556
478.4	0.087543	115.64	14.72371	0.000558
478.5	0.087571	115.836	14.74866	0.000558
478.6	0.087776	116.032	14.77362	0.00056
478.7	0.087809	116.228	14.79857	0.00056
478.8	0.087826	116.424	14.82353	0.00056
478.9	0.087938	116.62	14.84849	0.000561
479	0.088133	116.816	14.87344	0.000563
479.1	0.088171	117.012	14.8984	0.000564
479.2	0.088154	117.208	14.92335	0.000564
479.3	0.088248	117.404	14.94831	0.000565
479.4	0.088434	117.6	14.97326	0.000566
479.5	0.088448	117.796	14.99822	0.000567
479.6	0.08847	117.992	15.02317	0.000567
479.7	0.088616	118.188	15.04813	0.000568
479.8	0.088737	118.384	15.07308	0.000569
479.9	0.088775	118.58	15.09804	0.00057
480	0.088771	118.776	15.123	0.00057
480.1	0.088941	118.972	15.14795	0.000572
480.2	0.089023	119.168	15.17291	0.000572
480.3	0.089075	119.364	15.19786	0.000573
480.4	0.089129	119.56	15.22282	0.000573
480.5	0.089284	119.756	15.24777	0.000575
480.6	0.089293	119.952	15.27273	0.000575
480.7	0.089429	120.148	15.29768	0.000576
480.8	0.089517	120.344	15.32264	0.000577
480.9	0.089543	120.54	15.34759	0.000578

481	0.08963	120.736	15.37255	0.000578
481.1	0.089823	120.932	15.39751	0.00058
481.2	0.089825	121.128	15.42246	0.00058
481.3	0.089902	121.324	15.44742	0.000581
481.4	0.090036	121.52	15.47237	0.000582
481.5	0.090161	121.716	15.49733	0.000584
481.6	0.090196	121.912	15.52228	0.000584
481.7	0.090271	122.108	15.54724	0.000585
481.8	0.090334	122.304	15.57219	0.000585
481.9	0.090449	122.5	15.59715	0.000587
482	0.090505	122.696	15.6221	0.000587
482.1	0.090579	122.892	15.64706	0.000588
482.2	0.090654	123.088	15.67202	0.000589
482.3	0.090796	123.284	15.69697	0.00059
482.4	0.09083	123.48	15.72193	0.00059
482.5	0.09091	123.676	15.74688	0.000591
482.6	0.091028	123.872	15.77184	0.000592
482.7	0.091085	124.068	15.79679	0.000593
482.8	0.091177	124.264	15.82175	0.000594
482.9	0.091232	124.46	15.8467	0.000594
483	0.091309	124.656	15.87166	0.000595
483.1	0.0914	124.852	15.89661	0.000596
483.2	0.091556	125.048	15.92157	0.000598
483.3	0.091519	125.244	15.94652	0.000597
483.4	0.091647	125.44	15.97148	0.000599
483.5	0.091748	125.636	15.99644	0.0006
483.6	0.091887	125.832	16.02139	0.000601
483.7	0.09193	126.028	16.04635	0.000601
483.8	0.091965	126.224	16.0713	0.000602
483.9	0.092058	126.42	16.09626	0.000603
484	0.09222	126.616	16.12121	0.000604
484.1	0.092209	126.812	16.14617	0.000604
484.2	0.09233	127.008	16.17112	0.000605
484.3	0.092433	127.204	16.19608	0.000606
484.4	0.092524	127.4	16.22103	0.000607
484.5	0.092561	127.596	16.24599	0.000608
484.6	0.092678	127.792	16.27095	0.000609
484.7	0.092706	127.988	16.2959	0.000609
484.8	0.092851	128.184	16.32086	0.000611
484.9	0.092899	128.38	16.34581	0.000611
485	0.093006	128.576	16.37077	0.000612
485.1	0.093018	128.772	16.39572	0.000612
485.2	0.09317	128.968	16.42068	0.000614
485.3	0.093275	129.164	16.44563	0.000615
485.4	0.093282	129.36	16.47059	0.000615
485.5	0.093399	129.556	16.49554	0.000616
485.6	0.093535	129.752	16.5205	0.000617
485.7	0.093555	129.948	16.54546	0.000618
485.8	0.093638	130.144	16.57041	0.000618
485.9	0.093775	130.34	16.59537	0.00062
486	0.093765	130.536	16.62032	0.00062
486.1	0.093917	130.732	16.64528	0.000621
486.2	0.094007	130.928	16.67023	0.000622
486.3	0.094028	131.124	16.69519	0.000622
486.4	0.094062	131.32	16.72014	0.000623

486.5	0.094274	131.516	16.7451	0.000625
486.6	0.09428	131.712	16.77005	0.000625
486.7	0.094332	131.908	16.79501	0.000625
486.8	0.094452	132.104	16.81997	0.000627
486.9	0.094571	132.3	16.84492	0.000628
487	0.094583	132.496	16.86988	0.000628
487.1	0.094697	132.692	16.89483	0.000629
487.2	0.09478	132.888	16.91979	0.00063
487.3	0.094823	133.084	16.94474	0.00063
487.4	0.094929	133.28	16.9697	0.000631
487.5	0.095028	133.476	16.99465	0.000632
487.6	0.095052	133.672	17.01961	0.000633
487.7	0.095143	133.868	17.04456	0.000634
487.8	0.095357	134.064	17.06952	0.000636
487.9	0.095341	134.26	17.09447	0.000636
488	0.095424	134.456	17.11943	0.000636
488.1	0.095521	134.652	17.14439	0.000637
488.2	0.095688	134.848	17.16934	0.000639
488.3	0.095691	135.044	17.1943	0.000639
488.4	0.095738	135.24	17.21925	0.000639
488.5	0.095908	135.436	17.24421	0.000641
488.6	0.095973	135.632	17.26916	0.000642
488.7	0.096006	135.828	17.29412	0.000642
488.8	0.096079	136.024	17.31907	0.000643
488.9	0.096195	136.22	17.34403	0.000644
489	0.096206	136.416	17.36898	0.000644
489.1	0.096347	136.612	17.39394	0.000646
489.2	0.096335	136.808	17.4189	0.000645
489.3	0.096494	137.004	17.44385	0.000647
489.4	0.096579	137.2	17.46881	0.000648
489.5	0.096621	137.396	17.49376	0.000648
489.6	0.096694	137.592	17.51872	0.000649
489.7	0.096763	137.788	17.54367	0.00065
489.8	0.096847	137.984	17.56863	0.000651
489.9	0.09699	138.18	17.59358	0.000652
490	0.097099	138.376	17.61854	0.000653
490.1	0.097074	138.572	17.64349	0.000653
490.2	0.097255	138.768	17.66845	0.000655
490.3	0.097283	138.964	17.69341	0.000655
490.4	0.097425	139.16	17.71836	0.000656
490.5	0.097528	139.356	17.74332	0.000657
490.6	0.097593	139.552	17.76827	0.000658
490.7	0.097591	139.748	17.79323	0.000658
490.8	0.097778	139.944	17.81818	0.00066
490.9	0.097845	140.14	17.84314	0.000661
491	0.097869	140.336	17.86809	0.000661
491.1	0.098024	140.532	17.89305	0.000662
491.2	0.098073	140.728	17.918	0.000663
491.3	0.098162	140.924	17.94296	0.000664
491.4	0.098236	141.12	17.96792	0.000664
491.5	0.09827	141.316	17.99287	0.000665
491.6	0.098302	141.512	18.01783	0.000665
491.7	0.098482	141.708	18.04278	0.000667
491.8	0.09852	141.904	18.06774	0.000667
491.9	0.098607	142.1	18.09269	0.000668

492	0.098668	142.296	18.11765	0.000669
492.1	0.098757	142.492	18.1426	0.00067
492.2	0.098883	142.688	18.16756	0.000671
492.3	0.098926	142.884	18.19251	0.000671
492.4	0.099025	143.08	18.21747	0.000672
492.5	0.099106	143.276	18.24243	0.000673
492.6	0.099277	143.472	18.26738	0.000675
492.7	0.099251	143.668	18.29234	0.000675
492.8	0.099308	143.864	18.31729	0.000675
492.9	0.099439	144.06	18.34225	0.000676
493	0.099565	144.256	18.3672	0.000678
493.1	0.099583	144.452	18.39216	0.000678
493.2	0.099687	144.648	18.41711	0.000679
493.3	0.099758	144.844	18.44207	0.00068
493.4	0.09985	145.04	18.46702	0.000681
493.5	0.100016	145.236	18.49198	0.000682
493.6	0.099985	145.432	18.51693	0.000682
493.7	0.100053	145.628	18.54189	0.000683
493.8	0.100163	145.824	18.56685	0.000684
493.9	0.100295	146.02	18.5918	0.000685
494	0.1003	146.216	18.61676	0.000685
494.1	0.100394	146.412	18.64171	0.000686
494.2	0.100455	146.608	18.66667	0.000687
494.3	0.100636	146.804	18.69162	0.000688
494.4	0.10068	147	18.71658	0.000689
494.5	0.100714	147.196	18.74153	0.000689
494.6	0.100806	147.392	18.76649	0.00069
494.7	0.100905	147.588	18.79144	0.000691
494.8	0.100998	147.784	18.8164	0.000692
494.9	0.101052	147.98	18.84136	0.000693
495	0.101144	148.176	18.86631	0.000694
495.1	0.101229	148.372	18.89127	0.000694
495.2	0.101344	148.568	18.91622	0.000696
495.3	0.101354	148.764	18.94118	0.000696
495.4	0.101467	148.96	18.96613	0.000697
495.5	0.101509	149.156	18.99109	0.000697
495.6	0.101636	149.352	19.01604	0.000698
495.7	0.101692	149.548	19.041	0.000699
495.8	0.10173	149.744	19.06595	0.000699
495.9	0.101809	149.94	19.09091	0.0007
496	0.101936	150.136	19.11587	0.000701
496.1	0.102021	150.332	19.14082	0.000702
496.2	0.102031	150.528	19.16578	0.000702
496.3	0.102149	150.724	19.19073	0.000704
496.4	0.10224	150.92	19.21569	0.000704
496.5	0.102346	151.116	19.24064	0.000706
496.6	0.102367	151.312	19.2656	0.000706
496.7	0.102474	151.508	19.29055	0.000707
496.8	0.102534	151.704	19.31551	0.000707
496.9	0.102685	151.9	19.34046	0.000709
497	0.102703	152.096	19.36542	0.000709
497.1	0.102758	152.292	19.39038	0.00071
497.2	0.102861	152.488	19.41533	0.000711
497.3	0.103023	152.684	19.44029	0.000712
497.4	0.103036	152.88	19.46524	0.000712

497.5	0.103087	153.076	19.4902	0.000713
497.6	0.103188	153.272	19.51515	0.000714
497.7	0.10333	153.468	19.54011	0.000715
497.8	0.103331	153.664	19.56506	0.000715
497.9	0.103404	153.86	19.59002	0.000716
498	0.103515	154.056	19.61497	0.000717
498.1	0.103605	154.252	19.63993	0.000718
498.2	0.103693	154.448	19.66489	0.000719
498.3	0.103739	154.644	19.68984	0.000719
498.4	0.103809	154.84	19.7148	0.00072
498.5	0.103908	155.036	19.73975	0.000721
498.6	0.104078	155.232	19.76471	0.000723
498.7	0.104049	155.428	19.78966	0.000723
498.8	0.104131	155.624	19.81462	0.000723
498.9	0.104251	155.82	19.83957	0.000725
499	0.104354	156.016	19.86453	0.000726
499.1	0.104368	156.212	19.88948	0.000726
499.2	0.104453	156.408	19.91444	0.000727
499.3	0.104525	156.604	19.93939	0.000727
499.4	0.104664	156.8	19.96435	0.000729
499.5	0.104729	156.996	19.98931	0.000729
499.6	0.104772	157.192	20.01426	0.00073
499.7	0.104885	157.388	20.03922	0.000731
499.8	0.104941	157.584	20.06417	0.000732
499.9	0.105041	157.78	20.08913	0.000733
500	0.10507	157.976	20.11408	0.000733
500.1	0.10514	158.172	20.13904	0.000733
500.2	0.105245	158.368	20.16399	0.000735
500.3	0.105424	158.564	20.18895	0.000736
500.4	0.105406	158.76	20.2139	0.000736
500.5	0.10552	158.956	20.23886	0.000737
500.6	0.105631	159.152	20.26382	0.000738
500.7	0.105763	159.348	20.28877	0.00074
500.8	0.105708	159.544	20.31373	0.000739

B.1.8 Elastic Modulus test results of SFRGC(Na) at 400°C temperature.

Time	Absolute	Force	Stress	Strain
402.3	0.121377	0	0	0
402.4	0.121591	0.196	0.024955	2.14E-06
402.5	0.121751	0.392	0.049911	3.75E-06
402.6	0.121926	0.588	0.074866	5.5E-06
402.7	0.122174	0.784	0.099822	7.97E-06
402.8	0.122374	0.98	0.124777	9.97E-06
402.9	0.122559	1.176	0.149733	1.18E-05
403	0.122782	1.372	0.174688	1.41E-05
403.1	0.122945	1.568	0.199644	1.57E-05
403.2	0.123167	1.764	0.224599	1.79E-05
403.3	0.123367	1.96	0.249554	1.99E-05
403.4	0.123571	2.156	0.27451	2.19E-05

403.5	0.123761	2.352	0.299465	2.38E-05
403.6	0.123957	2.548	0.324421	2.58E-05
403.7	0.124193	2.744	0.349376	2.82E-05
403.8	0.1244	2.94	0.374332	3.02E-05
403.9	0.12463	3.136	0.399287	3.25E-05
404	0.124765	3.332	0.424242	3.39E-05
404.1	0.124962	3.528	0.449198	3.59E-05
404.2	0.125209	3.724	0.474153	3.83E-05
404.3	0.125349	3.92	0.499109	3.97E-05
404.4	0.125521	4.116	0.524064	4.14E-05
404.5	0.125759	4.312	0.54902	4.38E-05
404.6	0.125967	4.508	0.573975	4.59E-05
404.7	0.126155	4.704	0.598931	4.78E-05
404.8	0.126393	4.9	0.623886	5.02E-05
404.9	0.126571	5.096	0.648841	5.19E-05
405	0.126731	5.292	0.673797	5.35E-05
405.1	0.126947	5.488	0.698752	5.57E-05
405.2	0.127141	5.684	0.723708	5.76E-05
405.3	0.127332	5.88	0.748663	5.96E-05
405.4	0.127533	6.076	0.773619	6.16E-05
405.5	0.127722	6.272	0.798574	6.35E-05
405.6	0.127909	6.468	0.823529	6.53E-05
405.7	0.128075	6.664	0.848485	6.7E-05
405.8	0.128309	6.86	0.87344	6.93E-05
405.9	0.128503	7.056	0.898396	7.13E-05
406	0.128685	7.252	0.923351	7.31E-05
406.1	0.128851	7.448	0.948307	7.47E-05
406.2	0.129024	7.644	0.973262	7.65E-05
406.3	0.129228	7.84	0.998218	7.85E-05
406.4	0.129485	8.036	1.023173	8.11E-05
406.5	0.129667	8.232	1.048128	8.29E-05
406.6	0.129834	8.428	1.073084	8.46E-05
406.7	0.130017	8.624	1.098039	8.64E-05
406.8	0.130197	8.82	1.122995	8.82E-05
406.9	0.130407	9.016	1.14795	9.03E-05
407	0.130599	9.212	1.172906	9.22E-05
407.1	0.130807	9.408	1.197861	9.43E-05
407.2	0.130996	9.604	1.222816	9.62E-05
407.3	0.131176	9.8	1.247772	9.8E-05
407.4	0.131372	9.996	1.272727	1E-04
407.5	0.131595	10.192	1.297683	0.000102
407.6	0.131807	10.388	1.322638	0.000104
407.7	0.131975	10.584	1.347594	0.000106
407.8	0.132142	10.78	1.372549	0.000108
407.9	0.13232	10.976	1.397505	0.000109
408	0.132501	11.172	1.42246	0.000111
408.1	0.132691	11.368	1.447415	0.000113
408.2	0.132884	11.564	1.472371	0.000115
408.3	0.133064	11.76	1.497326	0.000117
408.4	0.133238	11.956	1.522282	0.000119
408.5	0.133444	12.152	1.547237	0.000121
408.6	0.133617	12.348	1.572193	0.000122
408.7	0.133809	12.544	1.597148	0.000124
408.8	0.13399	12.74	1.622103	0.000126
408.9	0.134169	12.936	1.647059	0.000128

409	0.134414	13.132	1.672014	0.00013
409.1	0.134555	13.328	1.69697	0.000132
409.2	0.134768	13.524	1.721925	0.000134
409.3	0.134936	13.72	1.746881	0.000136
409.4	0.135068	13.916	1.771836	0.000137
409.5	0.135236	14.112	1.796792	0.000139
409.6	0.135458	14.308	1.821747	0.000141
409.7	0.135645	14.504	1.846702	0.000143
409.8	0.135837	14.7	1.871658	0.000145
409.9	0.136025	14.896	1.896613	0.000146
410	0.13619	15.092	1.921569	0.000148
410.1	0.136364	15.288	1.946524	0.00015
410.2	0.136568	15.484	1.97148	0.000152
410.3	0.136728	15.68	1.996435	0.000154
410.4	0.136846	15.876	2.02139	0.000155
410.5	0.137077	16.072	2.046346	0.000157
410.6	0.137298	16.268	2.071301	0.000159
410.7	0.137467	16.464	2.096257	0.000161
410.8	0.137647	16.66	2.121212	0.000163
410.9	0.137779	16.856	2.146168	0.000164
411	0.137914	17.052	2.171123	0.000165
411.1	0.138201	17.248	2.196079	0.000168
411.2	0.138357	17.444	2.221034	0.00017
411.3	0.138543	17.64	2.245989	0.000172
411.4	0.138707	17.836	2.270945	0.000173
411.5	0.138935	18.032	2.2959	0.000176
411.6	0.139049	18.228	2.320856	0.000177
411.7	0.139265	18.424	2.345811	0.000179
411.8	0.13941	18.62	2.370767	0.00018
411.9	0.139682	18.816	2.395722	0.000183
412	0.139822	19.012	2.420677	0.000184
412.1	0.140022	19.208	2.445633	0.000186
412.2	0.140178	19.404	2.470588	0.000188
412.3	0.14034	19.6	2.495544	0.00019
412.4	0.140534	19.796	2.520499	0.000192
412.5	0.140674	19.992	2.545455	0.000193
412.6	0.140837	20.188	2.57041	0.000195
412.7	0.140966	20.384	2.595366	0.000196
412.8	0.141174	20.58	2.620321	0.000198
412.9	0.141297	20.776	2.645276	0.000199
413	0.141457	20.972	2.670232	0.000201
413.1	0.141653	21.168	2.695187	0.000203
413.2	0.141929	21.364	2.720143	0.000206
413.3	0.142122	21.56	2.745098	0.000207
413.4	0.142201	21.756	2.770054	0.000208
413.5	0.142396	21.952	2.795009	0.00021
413.6	0.142624	22.148	2.819964	0.000212
413.7	0.142744	22.344	2.84492	0.000214
413.8	0.142823	22.54	2.869875	0.000214
413.9	0.143157	22.736	2.894831	0.000218
414	0.143369	22.932	2.919786	0.00022
414.1	0.14343	23.128	2.944742	0.000221
414.2	0.14365	23.324	2.969697	0.000223
414.3	0.14385	23.52	2.994653	0.000225
414.4	0.143857	23.716	3.019608	0.000225

414.5	0.144061	23.912	3.044563	0.000227
414.6	0.144436	24.108	3.069519	0.000231
414.7	0.144539	24.304	3.094474	0.000232
414.8	0.144693	24.5	3.11943	0.000233
414.9	0.144879	24.696	3.144385	0.000235
415	0.145052	24.892	3.169341	0.000237
415.1	0.145086	25.088	3.194296	0.000237
415.2	0.145273	25.284	3.219251	0.000239
415.3	0.145644	25.48	3.244207	0.000243
415.4	0.14575	25.676	3.269162	0.000244
415.5	0.145796	25.872	3.294118	0.000244
415.6	0.145916	26.068	3.319073	0.000245
415.7	0.146161	26.264	3.344029	0.000248
415.8	0.146457	26.46	3.368984	0.000251
415.9	0.146489	26.656	3.39394	0.000251
416	0.146599	26.852	3.418895	0.000252
416.1	0.146714	27.048	3.44385	0.000253
416.2	0.147035	27.244	3.468806	0.000257
416.3	0.147287	27.44	3.493761	0.000259
416.4	0.147349	27.636	3.518717	0.00026
416.5	0.147423	27.832	3.543672	0.00026
416.6	0.147718	28.028	3.568628	0.000263
416.7	0.147872	28.224	3.593583	0.000265
416.8	0.148051	28.42	3.618538	0.000267
416.9	0.148241	28.616	3.643494	0.000269
417	0.148261	28.812	3.668449	0.000269
417.1	0.148508	29.008	3.693405	0.000271
417.2	0.14875	29.204	3.71836	0.000274
417.3	0.148876	29.4	3.743316	0.000275
417.4	0.148908	29.596	3.768271	0.000275
417.5	0.149161	29.792	3.793227	0.000278
417.6	0.149238	29.988	3.818182	0.000279
417.7	0.149532	30.184	3.843137	0.000282
417.8	0.149804	30.38	3.868093	0.000284
417.9	0.1499	30.576	3.893048	0.000285
418	0.149961	30.772	3.918004	0.000286
418.1	0.150236	30.968	3.942959	0.000289
418.2	0.150483	31.164	3.967915	0.000291
418.3	0.150502	31.36	3.99287	0.000291
418.4	0.150556	31.556	4.017826	0.000292
418.5	0.150816	31.752	4.042781	0.000294
418.6	0.150984	31.948	4.067736	0.000296
418.7	0.15129	32.144	4.092692	0.000299
418.8	0.151336	32.34	4.117647	0.0003
418.9	0.15142	32.536	4.142603	0.0003
419	0.151688	32.732	4.167558	0.000303
419.1	0.151852	32.928	4.192514	0.000305
419.2	0.15205	33.124	4.217469	0.000307
419.3	0.152201	33.32	4.242424	0.000308
419.4	0.152194	33.516	4.26738	0.000308
419.5	0.152421	33.712	4.292335	0.00031
419.6	0.152542	33.908	4.317291	0.000312
419.7	0.15276	34.104	4.342246	0.000314
419.8	0.15298	34.3	4.367202	0.000316
419.9	0.153125	34.496	4.392157	0.000317

420	0.153349	34.692	4.417113	0.00032
420.1	0.153481	34.888	4.442068	0.000321
420.2	0.153469	35.084	4.467023	0.000321
420.3	0.153691	35.28	4.491979	0.000323
420.4	0.153932	35.476	4.516934	0.000326
420.5	0.154088	35.672	4.54189	0.000327
420.6	0.154163	35.868	4.566845	0.000328
420.7	0.154422	36.064	4.591801	0.00033
420.8	0.154583	36.26	4.616756	0.000332
420.9	0.154677	36.456	4.641711	0.000333
421	0.154709	36.652	4.666667	0.000333
421.1	0.15494	36.848	4.691622	0.000336
421.2	0.155204	37.044	4.716578	0.000338
421.3	0.155428	37.24	4.741533	0.000341
421.4	0.155423	37.436	4.766489	0.00034
421.5	0.155593	37.632	4.791444	0.000342
421.6	0.155727	37.828	4.8164	0.000344
421.7	0.155974	38.024	4.841355	0.000346
421.8	0.156105	38.22	4.86631	0.000347
421.9	0.15618	38.416	4.891266	0.000348
422	0.156427	38.612	4.916221	0.000351
422.1	0.156608	38.808	4.941177	0.000352
422.2	0.1567	39.004	4.966132	0.000353
422.3	0.156767	39.2	4.991088	0.000354
422.4	0.156972	39.396	5.016043	0.000356
422.5	0.157153	39.592	5.040998	0.000358
422.6	0.157225	39.788	5.065954	0.000358
422.7	0.157473	39.984	5.090909	0.000361
422.8	0.157552	40.18	5.115865	0.000362
422.9	0.157764	40.376	5.14082	0.000364
423	0.157864	40.572	5.165776	0.000365
423.1	0.158047	40.768	5.190731	0.000367
423.2	0.158213	40.964	5.215687	0.000368
423.3	0.158444	41.16	5.240642	0.000371
423.4	0.158489	41.356	5.265597	0.000371
423.5	0.158609	41.552	5.290553	0.000372
423.6	0.158832	41.748	5.315508	0.000375
423.7	0.158958	41.944	5.340464	0.000376
423.8	0.159116	42.14	5.365419	0.000377
423.9	0.159287	42.336	5.390375	0.000379
424	0.15947	42.532	5.41533	0.000381
424.1	0.15953	42.728	5.440285	0.000382
424.2	0.159727	42.924	5.465241	0.000384
424.3	0.15984	43.12	5.490196	0.000385
424.4	0.160046	43.316	5.515152	0.000387
424.5	0.160142	43.512	5.540107	0.000388
424.6	0.160346	43.708	5.565063	0.00039
424.7	0.160452	43.904	5.590018	0.000391
424.8	0.160661	44.1	5.614974	0.000393
424.9	0.160785	44.296	5.639929	0.000394
425	0.161001	44.492	5.664884	0.000396
425.1	0.161084	44.688	5.68984	0.000397
425.2	0.161294	44.884	5.714795	0.000399
425.3	0.1614	45.08	5.739751	0.0004
425.4	0.161593	45.276	5.764706	0.000402

425.5	0.161689	45.472	5.789662	0.000403
425.6	0.16192	45.668	5.814617	0.000405
425.7	0.161998	45.864	5.839572	0.000406
425.8	0.162211	46.06	5.864528	0.000408
425.9	0.162311	46.256	5.889483	0.000409
426	0.16249	46.452	5.914439	0.000411
426.1	0.162592	46.648	5.939394	0.000412
426.2	0.162804	46.844	5.96435	0.000414
426.3	0.162886	47.04	5.989305	0.000415
426.4	0.16305	47.236	6.014261	0.000417
426.5	0.163178	47.432	6.039216	0.000418
426.6	0.16338	47.628	6.064171	0.00042
426.7	0.163454	47.824	6.089127	0.000421
426.8	0.163627	48.02	6.114082	0.000423
426.9	0.163905	48.216	6.139038	0.000425
427	0.163999	48.412	6.163993	0.000426
427.1	0.164049	48.608	6.188949	0.000427
427.2	0.164217	48.804	6.213904	0.000428
427.3	0.164435	49	6.238859	0.000431
427.4	0.164609	49.196	6.263815	0.000432
427.5	0.164659	49.392	6.28877	0.000433
427.6	0.164836	49.588	6.313726	0.000435
427.7	0.164942	49.784	6.338681	0.000436
427.8	0.165187	49.98	6.363637	0.000438
427.9	0.165398	50.176	6.388592	0.00044
428	0.165547	50.372	6.413548	0.000442
428.1	0.165724	50.568	6.438503	0.000443
428.2	0.165867	50.764	6.463458	0.000445
428.3	0.165973	50.96	6.488414	0.000446
428.4	0.166141	51.156	6.513369	0.000448
428.5	0.166273	51.352	6.538325	0.000449
428.6	0.166415	51.548	6.56328	0.00045
428.7	0.166581	51.744	6.588236	0.000452
428.8	0.166755	51.94	6.613191	0.000454
428.9	0.166828	52.136	6.638146	0.000455
429	0.166956	52.332	6.663102	0.000456
429.1	0.167122	52.528	6.688057	0.000457
429.2	0.167153	52.724	6.713013	0.000458
429.3	0.167263	52.92	6.737968	0.000459
429.4	0.167482	53.116	6.762924	0.000461
429.5	0.167676	53.312	6.787879	0.000463
429.6	0.167703	53.508	6.812835	0.000463
429.7	0.167842	53.704	6.83779	0.000465
429.8	0.168022	53.9	6.862745	0.000466
429.9	0.168138	54.096	6.887701	0.000468
430	0.168276	54.292	6.912656	0.000469
430.1	0.168476	54.488	6.937612	0.000471
430.2	0.168612	54.684	6.962567	0.000472
430.3	0.168676	54.88	6.987523	0.000473
430.4	0.168877	55.076	7.012478	0.000475
430.5	0.169031	55.272	7.037433	0.000477
430.6	0.169122	55.468	7.062389	0.000477
430.7	0.169281	55.664	7.087344	0.000479
430.8	0.169455	55.86	7.1123	0.000481
430.9	0.169515	56.056	7.137255	0.000481

431	0.169689	56.252	7.162211	0.000483
431.1	0.169894	56.448	7.187166	0.000485
431.2	0.169977	56.644	7.212122	0.000486
431.3	0.170142	56.84	7.237077	0.000488
431.4	0.170244	57.036	7.262032	0.000489
431.5	0.170386	57.232	7.286988	0.00049
431.6	0.170563	57.428	7.311943	0.000492
431.7	0.170691	57.624	7.336899	0.000493
431.8	0.170836	57.82	7.361854	0.000495
431.9	0.170958	58.016	7.38681	0.000496
432	0.17112	58.212	7.411765	0.000497
432.1	0.171213	58.408	7.43672	0.000498
432.2	0.171373	58.604	7.461676	0.0005
432.3	0.171541	58.8	7.486631	0.000502
432.4	0.171653	58.996	7.511587	0.000503
432.5	0.171761	59.192	7.536542	0.000504
432.6	0.171927	59.388	7.561498	0.000506
432.7	0.17206	59.584	7.586453	0.000507
432.8	0.172179	59.78	7.611409	0.000508
432.9	0.172373	59.976	7.636364	0.00051
433	0.172547	60.172	7.661319	0.000512
433.1	0.172578	60.368	7.686275	0.000512
433.2	0.172753	60.564	7.71123	0.000514
433.3	0.172972	60.76	7.736186	0.000516
433.4	0.173029	60.956	7.761141	0.000517
433.5	0.173215	61.152	7.786097	0.000518
433.6	0.173365	61.348	7.811052	0.00052
433.7	0.173412	61.544	7.836008	0.00052
433.8	0.17357	61.74	7.860963	0.000522
433.9	0.173682	61.936	7.885918	0.000523
434	0.17384	62.132	7.910874	0.000525
434.1	0.173978	62.328	7.935829	0.000526
434.2	0.17416	62.524	7.960785	0.000528
434.3	0.174285	62.72	7.98574	0.000529
434.4	0.17441	62.916	8.010696	0.00053
434.5	0.174654	63.112	8.035651	0.000533
434.6	0.174767	63.308	8.060606	0.000534
434.7	0.174824	63.504	8.085562	0.000534
434.8	0.174992	63.7	8.110517	0.000536
434.9	0.175118	63.896	8.135473	0.000537
435	0.1752	64.092	8.160428	0.000538
435.1	0.17542	64.288	8.185384	0.00054
435.2	0.175601	64.484	8.210339	0.000542
435.3	0.175654	64.68	8.235295	0.000543
435.4	0.175812	64.876	8.26025	0.000544
435.5	0.175977	65.072	8.285205	0.000546
435.6	0.176019	65.268	8.310161	0.000546
435.7	0.176181	65.464	8.335116	0.000548
435.8	0.176349	65.66	8.360072	0.00055
435.9	0.176403	65.856	8.385027	0.00055
436	0.176582	66.052	8.409983	0.000552
436.1	0.176737	66.248	8.434938	0.000554
436.2	0.176774	66.444	8.459893	0.000554
436.3	0.17694	66.64	8.484849	0.000556
436.4	0.177128	66.836	8.509804	0.000558

436.5	0.177262	67.032	8.53476	0.000559
436.6	0.177395	67.228	8.559715	0.00056
436.7	0.177506	67.424	8.584671	0.000561
436.8	0.177651	67.62	8.609626	0.000563
436.9	0.177799	67.816	8.634582	0.000564
437	0.177912	68.012	8.659537	0.000565
437.1	0.178053	68.208	8.684492	0.000567
437.2	0.178228	68.404	8.709448	0.000569
437.3	0.178314	68.6	8.734403	0.000569
437.4	0.178485	68.796	8.759359	0.000571
437.5	0.178622	68.992	8.784314	0.000572
437.6	0.178732	69.188	8.80927	0.000574
437.7	0.178872	69.384	8.834225	0.000575
437.8	0.17903	69.58	8.85918	0.000577
437.9	0.17914	69.776	8.884136	0.000578
438	0.179271	69.972	8.909091	0.000579
438.1	0.1794	70.168	8.934047	0.00058
438.2	0.179458	70.364	8.959002	0.000581
438.3	0.179608	70.56	8.983958	0.000582
438.4	0.179805	70.756	9.008913	0.000584
438.5	0.179873	70.952	9.033869	0.000585
438.6	0.180061	71.148	9.058824	0.000587
438.7	0.180173	71.344	9.083779	0.000588
438.8	0.180263	71.54	9.108735	0.000589
438.9	0.180484	71.736	9.13369	0.000591
439	0.180555	71.932	9.158646	0.000592
439.1	0.18077	72.128	9.183601	0.000594
439.2	0.180883	72.324	9.208557	0.000595
439.3	0.180974	72.52	9.233512	0.000596
439.4	0.181183	72.716	9.258467	0.000598
439.5	0.181238	72.912	9.283423	0.000599
439.6	0.181366	73.108	9.308378	0.0006
439.7	0.181577	73.304	9.333334	0.000602
439.8	0.181616	73.5	9.358289	0.000602
439.9	0.181775	73.696	9.383245	0.000604
440	0.181977	73.892	9.4082	0.000606
440.1	0.182016	74.088	9.433156	0.000606
440.2	0.182136	74.284	9.458111	0.000608
440.3	0.182378	74.48	9.483066	0.00061
440.4	0.182427	74.676	9.508022	0.00061
440.5	0.182546	74.872	9.532977	0.000612
440.6	0.182686	75.068	9.557933	0.000613
440.7	0.182769	75.264	9.582888	0.000614
440.8	0.182897	75.46	9.607844	0.000615
440.9	0.183104	75.656	9.632799	0.000617
441	0.183124	75.852	9.657754	0.000617
441.1	0.183303	76.048	9.68271	0.000619
441.2	0.183442	76.244	9.707665	0.000621
441.3	0.183556	76.44	9.732621	0.000622
441.4	0.183737	76.636	9.757576	0.000624
441.5	0.18382	76.832	9.782532	0.000624
441.6	0.18396	77.028	9.807487	0.000626
441.7	0.184086	77.224	9.832443	0.000627
441.8	0.184166	77.42	9.857398	0.000628
441.9	0.184369	77.616	9.882353	0.00063

442	0.18446	77.812	9.907309	0.000631
442.1	0.184611	78.008	9.932264	0.000632
442.2	0.184778	78.204	9.95722	0.000634
442.3	0.184877	78.4	9.982175	0.000635
442.4	0.185045	78.596	10.00713	0.000637
442.5	0.185147	78.792	10.03209	0.000638
442.6	0.185274	78.988	10.05704	0.000639
442.7	0.185394	79.184	10.082	0.00064
442.8	0.185533	79.38	10.10695	0.000642
442.9	0.185639	79.576	10.13191	0.000643
443	0.185755	79.772	10.15686	0.000644
443.1	0.185918	79.968	10.18182	0.000645
443.2	0.186046	80.164	10.20677	0.000647
443.3	0.186136	80.36	10.23173	0.000648
443.4	0.186287	80.556	10.25668	0.000649
443.5	0.186426	80.752	10.28164	0.00065
443.6	0.186505	80.948	10.3066	0.000651
443.7	0.186661	81.144	10.33155	0.000653
443.8	0.186752	81.34	10.35651	0.000654
443.9	0.186878	81.536	10.38146	0.000655
444	0.18701	81.732	10.40642	0.000656
444.1	0.187154	81.928	10.43137	0.000658
444.2	0.18731	82.124	10.45633	0.000659
444.3	0.187439	82.32	10.48128	0.000661
444.4	0.187572	82.516	10.50624	0.000662
444.5	0.187666	82.712	10.53119	0.000663
444.6	0.18788	82.908	10.55615	0.000665
444.7	0.188009	83.104	10.58111	0.000666
444.8	0.188032	83.3	10.60606	0.000667
444.9	0.188235	83.496	10.63102	0.000669
445	0.188335	83.692	10.65597	0.00067
445.1	0.188418	83.888	10.68093	0.00067
445.2	0.188586	84.084	10.70588	0.000672
445.3	0.188679	84.28	10.73084	0.000673
445.4	0.188848	84.476	10.75579	0.000675
445.5	0.188947	84.672	10.78075	0.000676
445.6	0.189009	84.868	10.8057	0.000676
445.7	0.189167	85.064	10.83066	0.000678
445.8	0.189286	85.26	10.85562	0.000679
445.9	0.189424	85.456	10.88057	0.00068
446	0.189553	85.652	10.90553	0.000682
446.1	0.189699	85.848	10.93048	0.000683
446.2	0.189825	86.044	10.95544	0.000684
446.3	0.189917	86.24	10.98039	0.000685
446.4	0.19003	86.436	11.00535	0.000687
446.5	0.190165	86.632	11.0303	0.000688
446.6	0.190351	86.828	11.05526	0.00069
446.7	0.190463	87.024	11.08021	0.000691
446.8	0.190569	87.22	11.10517	0.000692
446.9	0.190734	87.416	11.13013	0.000694
447	0.190884	87.612	11.15508	0.000695
447.1	0.190947	87.808	11.18004	0.000696
447.2	0.191123	88.004	11.20499	0.000697
447.3	0.191286	88.2	11.22995	0.000699
447.4	0.191341	88.396	11.2549	0.0007

447.5	0.19151	88.592	11.27986	0.000701
447.6	0.191631	88.788	11.30481	0.000703
447.7	0.191776	88.984	11.32977	0.000704
447.8	0.191862	89.18	11.35472	0.000705
447.9	0.191991	89.376	11.37968	0.000706
448	0.192083	89.572	11.40464	0.000707
448.1	0.192192	89.768	11.42959	0.000708
448.2	0.192343	89.964	11.45455	0.00071
448.3	0.192434	90.16	11.4795	0.000711
448.4	0.192592	90.356	11.50446	0.000712
448.5	0.192722	90.552	11.52941	0.000713
448.6	0.192834	90.748	11.55437	0.000715
448.7	0.192932	90.944	11.57932	0.000716
448.8	0.193055	91.14	11.60428	0.000717
448.9	0.193187	91.336	11.62923	0.000718
449	0.193244	91.532	11.65419	0.000719
449.1	0.193424	91.728	11.67914	0.00072
449.2	0.19353	91.924	11.7041	0.000722
449.3	0.193629	92.12	11.72906	0.000723
449.4	0.193808	92.316	11.75401	0.000724
449.5	0.193893	92.512	11.77897	0.000725
449.6	0.194036	92.708	11.80392	0.000727
449.7	0.194196	92.904	11.82888	0.000728
449.8	0.194292	93.1	11.85383	0.000729
449.9	0.194419	93.296	11.87879	0.00073
450	0.194538	93.492	11.90374	0.000732
450.1	0.194639	93.688	11.9287	0.000733
450.2	0.19484	93.884	11.95365	0.000735
450.3	0.194898	94.08	11.97861	0.000735
450.4	0.195004	94.276	12.00357	0.000736
450.5	0.195136	94.472	12.02852	0.000738
450.6	0.195246	94.668	12.05348	0.000739
450.7	0.19536	94.864	12.07843	0.00074
450.8	0.195491	95.06	12.10339	0.000741
450.9	0.19563	95.256	12.12834	0.000743
451	0.195692	95.452	12.1533	0.000743
451.1	0.195846	95.648	12.17825	0.000745
451.2	0.195949	95.844	12.20321	0.000746
451.3	0.196048	96.04	12.22816	0.000747
451.4	0.196247	96.236	12.25312	0.000749
451.5	0.196334	96.432	12.27808	0.00075
451.6	0.196379	96.628	12.30303	0.00075
451.7	0.196578	96.824	12.32799	0.000752
451.8	0.196675	97.02	12.35294	0.000753
451.9	0.196819	97.216	12.3779	0.000754
452	0.196918	97.412	12.40285	0.000755
452.1	0.197022	97.608	12.42781	0.000756
452.2	0.197152	97.804	12.45276	0.000758
452.3	0.197305	98	12.47772	0.000759
452.4	0.197447	98.196	12.50267	0.000761

B.1.9 Elastic Modulus test results of SFRGC(Na) at 600°C temperature.

Time	Absolute	Force	Stress	Strain
160.1	0.082579	0	0	0
160.2	0.082951	0.196	0.024955	3.72E-06
160.3	0.083219	0.392	0.049911	6.39E-06
160.4	0.083519	0.588	0.074866	9.4E-06
160.5	0.083888	0.784	0.099822	1.31E-05
160.6	0.084277	0.98	0.124777	1.7E-05
160.7	0.084643	1.176	0.149733	2.06E-05
160.8	0.084998	1.372	0.174688	2.42E-05
160.9	0.085358	1.568	0.199644	2.78E-05
161	0.085702	1.764	0.224599	3.12E-05
161.1	0.086097	1.96	0.249554	3.52E-05
161.2	0.086478	2.156	0.27451	3.9E-05
161.3	0.086815	2.352	0.299465	4.24E-05
161.4	0.087176	2.548	0.324421	4.6E-05
161.5	0.087507	2.744	0.349376	4.93E-05
161.6	0.087797	2.94	0.374332	5.22E-05
161.7	0.088154	3.136	0.399287	5.57E-05
161.8	0.08848	3.332	0.424242	5.9E-05
161.9	0.088871	3.528	0.449198	6.29E-05
162	0.089235	3.724	0.474153	6.66E-05
162.1	0.089597	3.92	0.499109	7.02E-05
162.2	0.089953	4.116	0.524064	7.37E-05
162.3	0.090292	4.312	0.54902	7.71E-05
162.4	0.090615	4.508	0.573975	8.04E-05
162.5	0.090997	4.704	0.598931	8.42E-05
162.6	0.091317	4.9	0.623886	8.74E-05
162.7	0.091667	5.096	0.648841	9.09E-05
162.8	0.092006	5.292	0.673797	9.43E-05
162.9	0.092329	5.488	0.698752	9.75E-05
163	0.092669	5.684	0.723708	0.000101
163.1	0.093019	5.88	0.748663	0.000104
163.2	0.09334	6.076	0.773619	0.000108
163.3	0.093691	6.272	0.798574	0.000111
163.4	0.094008	6.468	0.823529	0.000114
163.5	0.094334	6.664	0.848485	0.000118
163.6	0.094703	6.86	0.87344	0.000121
163.7	0.094947	7.056	0.898396	0.000124
163.8	0.09523	7.252	0.923351	0.000127
163.9	0.095529	7.448	0.948307	0.000129
164	0.095901	7.644	0.973262	0.000133
164.1	0.096211	7.84	0.998218	0.000136
164.2	0.096522	8.036	1.023173	0.000139
164.3	0.09691	8.232	1.048128	0.000143
164.4	0.097204	8.428	1.073084	0.000146
164.5	0.097478	8.624	1.098039	0.000149
164.6	0.097822	8.82	1.122995	0.000152
164.7	0.098146	9.016	1.14795	0.000156
164.8	0.098429	9.212	1.172906	0.000158
164.9	0.098842	9.408	1.197861	0.000163
165	0.099198	9.604	1.222816	0.000166

165.1	0.099429	9.8	1.247772	0.000168
165.2	0.099719	9.996	1.272727	0.000171
165.3	0.10009	10.192	1.297683	0.000175
165.4	0.10051	10.388	1.322638	0.000179
165.5	0.100818	10.584	1.347594	0.000182
165.6	0.101132	10.78	1.372549	0.000186
165.7	0.101458	10.976	1.397505	0.000189
165.8	0.101719	11.172	1.42246	0.000191
165.9	0.102054	11.368	1.447415	0.000195
166	0.102374	11.564	1.472371	0.000198
166.1	0.102619	11.76	1.497326	0.0002
166.2	0.102936	11.956	1.522282	0.000204
166.3	0.103241	12.152	1.547237	0.000207
166.4	0.10353	12.348	1.572193	0.00021
166.5	0.103794	12.544	1.597148	0.000212
166.6	0.104103	12.74	1.622103	0.000215
166.7	0.104435	12.936	1.647059	0.000219
166.8	0.104731	13.132	1.672014	0.000222
166.9	0.104965	13.328	1.69697	0.000224
167	0.105263	13.524	1.721925	0.000227
167.1	0.105554	13.72	1.746881	0.00023
167.2	0.105896	13.916	1.771836	0.000233
167.3	0.106205	14.112	1.796792	0.000236
167.4	0.106428	14.308	1.821747	0.000238
167.5	0.106731	14.504	1.846702	0.000242
167.6	0.107007	14.7	1.871658	0.000244
167.7	0.107392	14.896	1.896613	0.000248
167.8	0.107712	15.092	1.921569	0.000251
167.9	0.107874	15.288	1.946524	0.000253
168	0.108196	15.484	1.97148	0.000256
168.1	0.108544	15.68	1.996435	0.00026
168.2	0.108751	15.876	2.02139	0.000262
168.3	0.108945	16.072	2.046346	0.000264
168.4	0.109326	16.268	2.071301	0.000267
168.5	0.109633	16.464	2.096257	0.000271
168.6	0.109863	16.66	2.121212	0.000273
168.7	0.110128	16.856	2.146168	0.000275
168.8	0.110388	17.052	2.171123	0.000278
168.9	0.110773	17.248	2.196079	0.000282
169	0.111057	17.444	2.221034	0.000285
169.1	0.111245	17.64	2.245989	0.000287
169.2	0.11147	17.836	2.270945	0.000289
169.3	0.111787	18.032	2.2959	0.000292
169.4	0.112103	18.228	2.320856	0.000295
169.5	0.112349	18.424	2.345811	0.000298
169.6	0.112647	18.62	2.370767	0.000301
169.7	0.112971	18.816	2.395722	0.000304
169.8	0.113176	19.012	2.420677	0.000306
169.9	0.113412	19.208	2.445633	0.000308
170	0.113749	19.404	2.470588	0.000312
170.1	0.113965	19.6	2.495544	0.000314
170.2	0.11426	19.796	2.520499	0.000317
170.3	0.11452	19.992	2.545455	0.000319
170.4	0.114789	20.188	2.57041	0.000322
170.5	0.115053	20.384	2.595366	0.000325

170.6	0.11534	20.58	2.620321	0.000328
170.7	0.11561	20.776	2.645276	0.00033
170.8	0.115895	20.972	2.670232	0.000333
170.9	0.116139	21.168	2.695187	0.000336
171	0.116436	21.364	2.720143	0.000339
171.1	0.116702	21.56	2.745098	0.000341
171.2	0.116936	21.756	2.770054	0.000344
171.3	0.117222	21.952	2.795009	0.000346
171.4	0.117467	22.148	2.819964	0.000349
171.5	0.117692	22.344	2.84492	0.000351
171.6	0.117931	22.54	2.869875	0.000354
171.7	0.118254	22.736	2.894831	0.000357
171.8	0.118516	22.932	2.919786	0.000359
171.9	0.118765	23.128	2.944742	0.000362
172	0.119043	23.324	2.969697	0.000365
172.1	0.119275	23.52	2.994653	0.000367
172.2	0.119529	23.716	3.019608	0.000369
172.3	0.119799	23.912	3.044563	0.000372
172.4	0.120059	24.108	3.069519	0.000375
172.5	0.120297	24.304	3.094474	0.000377
172.6	0.12051	24.5	3.11943	0.000379
172.7	0.120798	24.696	3.144385	0.000382
172.8	0.121059	24.892	3.169341	0.000385
172.9	0.121304	25.088	3.194296	0.000387
173	0.121543	25.284	3.219251	0.00039
173.1	0.121827	25.48	3.244207	0.000392
173.2	0.122098	25.676	3.269162	0.000395
173.3	0.122334	25.872	3.294118	0.000398
173.4	0.122577	26.068	3.319073	0.0004
173.5	0.122841	26.264	3.344029	0.000403
173.6	0.123096	26.46	3.368984	0.000405
173.7	0.123342	26.656	3.39394	0.000408
173.8	0.123541	26.852	3.418895	0.00041
173.9	0.123839	27.048	3.44385	0.000413
174	0.124081	27.244	3.468806	0.000415
174.1	0.124316	27.44	3.493761	0.000417
174.2	0.124536	27.636	3.518717	0.00042
174.3	0.124824	27.832	3.543672	0.000422
174.4	0.125097	28.028	3.568628	0.000425
174.5	0.125312	28.224	3.593583	0.000427
174.6	0.125537	28.42	3.618538	0.00043
174.7	0.125783	28.616	3.643494	0.000432
174.8	0.126039	28.812	3.668449	0.000435
174.9	0.126311	29.008	3.693405	0.000437
175	0.126551	29.204	3.71836	0.00044
175.1	0.126809	29.4	3.743316	0.000442
175.2	0.127042	29.596	3.768271	0.000445
175.3	0.127287	29.792	3.793227	0.000447
175.4	0.127505	29.988	3.818182	0.000449
175.5	0.127775	30.184	3.843137	0.000452
175.6	0.127967	30.38	3.868093	0.000454
175.7	0.128184	30.576	3.893048	0.000456
175.8	0.12846	30.772	3.918004	0.000459
175.9	0.128676	30.968	3.942959	0.000461
176	0.128904	31.164	3.967915	0.000463

176.1	0.129152	31.36	3.99287	0.000466
176.2	0.129356	31.556	4.017826	0.000468
176.3	0.129622	31.752	4.042781	0.00047
176.4	0.129865	31.948	4.067736	0.000473
176.5	0.13006	32.144	4.092692	0.000475
176.6	0.130255	32.34	4.117647	0.000477
176.7	0.130531	32.536	4.142603	0.00048
176.8	0.130795	32.732	4.167558	0.000482
176.9	0.131026	32.928	4.192514	0.000484
177	0.131209	33.124	4.217469	0.000486
177.1	0.13146	33.32	4.242424	0.000489
177.2	0.131681	33.516	4.26738	0.000491
177.3	0.131902	33.712	4.292335	0.000493
177.4	0.132119	33.908	4.317291	0.000495
177.5	0.132346	34.104	4.342246	0.000498
177.6	0.132593	34.3	4.367202	0.0005
177.7	0.132842	34.496	4.392157	0.000503
177.8	0.133064	34.692	4.417113	0.000505
177.9	0.133231	34.888	4.442068	0.000507
178	0.133455	35.084	4.467023	0.000509
178.1	0.133742	35.28	4.491979	0.000512
178.2	0.133964	35.476	4.516934	0.000514
178.3	0.1342	35.672	4.54189	0.000516
178.4	0.134438	35.868	4.566845	0.000519
178.5	0.13468	36.064	4.591801	0.000521
178.6	0.134923	36.26	4.616756	0.000523
178.7	0.13519	36.456	4.641711	0.000526
178.8	0.135412	36.652	4.666667	0.000528
178.9	0.135603	36.848	4.691622	0.00053
179	0.13584	37.044	4.716578	0.000533
179.1	0.136036	37.24	4.741533	0.000535
179.2	0.136205	37.436	4.766489	0.000536
179.3	0.136432	37.632	4.791444	0.000539
179.4	0.136647	37.828	4.8164	0.000541
179.5	0.136894	38.024	4.841355	0.000543
179.6	0.137164	38.22	4.86631	0.000546
179.7	0.137411	38.416	4.891266	0.000548
179.8	0.137558	38.612	4.916221	0.00055
179.9	0.137805	38.808	4.941177	0.000552
180	0.138061	39.004	4.966132	0.000555
180.1	0.138317	39.2	4.991088	0.000557
180.2	0.138493	39.396	5.016043	0.000559
180.3	0.13873	39.592	5.040998	0.000562
180.4	0.138903	39.788	5.065954	0.000563
180.5	0.139211	39.984	5.090909	0.000566
180.6	0.139394	40.18	5.115865	0.000568
180.7	0.139541	40.376	5.14082	0.00057
180.8	0.139725	40.572	5.165776	0.000571
180.9	0.140078	40.768	5.190731	0.000575
181	0.140249	40.964	5.215687	0.000577
181.1	0.140474	41.16	5.240642	0.000579
181.2	0.140634	41.356	5.265597	0.000581
181.3	0.14089	41.552	5.290553	0.000583
181.4	0.141175	41.748	5.315508	0.000586
181.5	0.141295	41.944	5.340464	0.000587

181.6	0.141589	42.14	5.365419	0.00059
181.7	0.141721	42.336	5.390375	0.000591
181.8	0.141946	42.532	5.41533	0.000594
181.9	0.142216	42.728	5.440285	0.000596
182	0.142335	42.924	5.465241	0.000598
182.1	0.14266	43.12	5.490196	0.000601
182.2	0.142853	43.316	5.515152	0.000603
182.3	0.143051	43.512	5.540107	0.000605
182.4	0.143271	43.708	5.565063	0.000607
182.5	0.143346	43.904	5.590018	0.000608
182.6	0.143504	44.1	5.614974	0.000609
182.7	0.143652	44.296	5.639929	0.000611
182.8	0.144004	44.492	5.664884	0.000614
182.9	0.144432	44.688	5.68984	0.000619
183	0.144553	44.884	5.714795	0.00062
183.1	0.144779	45.08	5.739751	0.000622
183.2	0.145002	45.276	5.764706	0.000624
183.3	0.145084	45.472	5.789662	0.000625
183.4	0.14534	45.668	5.814617	0.000628
183.5	0.145595	45.864	5.839572	0.00063
183.6	0.145855	46.06	5.864528	0.000633
183.7	0.145997	46.256	5.889483	0.000634
183.8	0.146071	46.452	5.914439	0.000635
183.9	0.146255	46.648	5.939394	0.000637
184	0.146668	46.844	5.96435	0.000641
184.1	0.146922	47.04	5.989305	0.000643
184.2	0.146953	47.236	6.014261	0.000644
184.3	0.147078	47.432	6.039216	0.000645
184.4	0.147473	47.628	6.064171	0.000649
184.5	0.147782	47.824	6.089127	0.000652
184.6	0.147799	48.02	6.114082	0.000652
184.7	0.147941	48.216	6.139038	0.000654
184.8	0.148314	48.412	6.163993	0.000657
184.9	0.148554	48.608	6.188949	0.00066
185	0.148714	48.804	6.213904	0.000661
185.1	0.148764	49	6.238859	0.000662
185.2	0.149078	49.196	6.263815	0.000665
185.3	0.14931	49.392	6.28877	0.000667
185.4	0.149482	49.588	6.313726	0.000669
185.5	0.149575	49.784	6.338681	0.00067
185.6	0.149798	49.98	6.363637	0.000672
185.7	0.150116	50.176	6.388592	0.000675
185.8	0.150296	50.372	6.413548	0.000677
185.9	0.150507	50.568	6.438503	0.000679
186	0.150724	50.764	6.463458	0.000681
186.1	0.150942	50.96	6.488414	0.000684
186.2	0.151188	51.156	6.513369	0.000686
186.3	0.151349	51.352	6.538325	0.000688
186.4	0.151355	51.548	6.56328	0.000688
186.5	0.151584	51.744	6.588236	0.00069
186.6	0.1518	51.94	6.613191	0.000692
186.7	0.15213	52.136	6.638146	0.000696
186.8	0.152392	52.332	6.663102	0.000698
186.9	0.152376	52.528	6.688057	0.000698
187	0.152548	52.724	6.713013	0.0007

187.1	0.152787	52.92	6.737968	0.000702
187.2	0.153054	53.116	6.762924	0.000705
187.3	0.153324	53.312	6.787879	0.000707
187.4	0.153571	53.508	6.812835	0.00071
187.5	0.153574	53.704	6.83779	0.00071
187.6	0.153711	53.9	6.862745	0.000711
187.7	0.153895	54.096	6.887701	0.000713
187.8	0.154144	54.292	6.912656	0.000716
187.9	0.154311	54.488	6.937612	0.000717
188	0.154505	54.684	6.962567	0.000719
188.1	0.154721	54.88	6.987523	0.000721
188.2	0.154895	55.076	7.012478	0.000723
188.3	0.155087	55.272	7.037433	0.000725
188.4	0.155312	55.468	7.062389	0.000727
188.5	0.155521	55.664	7.087344	0.000729
188.6	0.155666	55.86	7.1123	0.000731
188.7	0.155895	56.056	7.137255	0.000733
188.8	0.156137	56.252	7.162211	0.000736
188.9	0.156319	56.448	7.187166	0.000737
189	0.156422	56.644	7.212122	0.000738
189.1	0.15668	56.84	7.237077	0.000741
189.2	0.156892	57.036	7.262032	0.000743
189.3	0.157062	57.232	7.286988	0.000745
189.4	0.157197	57.428	7.311943	0.000746
189.5	0.15748	57.624	7.336899	0.000749
189.6	0.15776	57.82	7.361854	0.000752
189.7	0.157952	58.016	7.38681	0.000754
189.8	0.158082	58.212	7.411765	0.000755
189.9	0.158232	58.408	7.43672	0.000757
190	0.158348	58.604	7.461676	0.000758
190.1	0.158623	58.8	7.486631	0.00076
190.2	0.158797	58.996	7.511587	0.000762
190.3	0.159018	59.192	7.536542	0.000764
190.4	0.159101	59.388	7.561498	0.000765
190.5	0.159342	59.584	7.586453	0.000768
190.6	0.159535	59.78	7.611409	0.00077
190.7	0.15973	59.976	7.636364	0.000772
190.8	0.159925	60.172	7.661319	0.000773
190.9	0.160122	60.368	7.686275	0.000775
191	0.160252	60.564	7.71123	0.000777
191.1	0.16043	60.76	7.736186	0.000779
191.2	0.160686	60.956	7.761141	0.000781
191.3	0.160834	61.152	7.786097	0.000783
191.4	0.161005	61.348	7.811052	0.000784
191.5	0.161191	61.544	7.836008	0.000786
191.6	0.161408	61.74	7.860963	0.000788
191.7	0.161582	61.936	7.885918	0.00079
191.8	0.161717	62.132	7.910874	0.000791
191.9	0.161837	62.328	7.935829	0.000793
192	0.162101	62.524	7.960785	0.000795
192.1	0.16235	62.72	7.98574	0.000798
192.2	0.162425	62.916	8.010696	0.000798
192.3	0.162639	63.112	8.035651	0.000801
192.4	0.162911	63.308	8.060606	0.000803
192.5	0.162998	63.504	8.085562	0.000804

192.6	0.163169	63.7	8.110517	0.000806
192.7	0.163445	63.896	8.135473	0.000809
192.8	0.163624	64.092	8.160428	0.00081
192.9	0.163776	64.288	8.185384	0.000812
193	0.163958	64.484	8.210339	0.000814
193.1	0.164162	64.68	8.235295	0.000816
193.2	0.164296	64.876	8.26025	0.000817
193.3	0.164542	65.072	8.285205	0.00082
193.4	0.164747	65.268	8.310161	0.000822
193.5	0.164847	65.464	8.335116	0.000823
193.6	0.165054	65.66	8.360072	0.000825
193.7	0.165304	65.856	8.385027	0.000827
193.8	0.165428	66.052	8.409983	0.000828
193.9	0.165642	66.248	8.434938	0.000831
194	0.165783	66.444	8.459893	0.000832
194.1	0.165965	66.64	8.484849	0.000834
194.2	0.166187	66.836	8.509804	0.000836
194.3	0.166376	67.032	8.53476	0.000838
194.4	0.166526	67.228	8.559715	0.000839
194.5	0.166727	67.424	8.584671	0.000841
194.6	0.166842	67.62	8.609626	0.000843
194.7	0.16701	67.816	8.634582	0.000844
194.8	0.167251	68.012	8.659537	0.000847
194.9	0.167381	68.208	8.684492	0.000848
195	0.167557	68.404	8.709448	0.00085
195.1	0.167657	68.6	8.734403	0.000851
195.2	0.167848	68.796	8.759359	0.000853
195.3	0.168064	68.992	8.784314	0.000855
195.4	0.1683	69.188	8.80927	0.000857
195.5	0.168423	69.384	8.834225	0.000858
195.6	0.168585	69.58	8.85918	0.00086
195.7	0.168855	69.776	8.884136	0.000863
195.8	0.16893	69.972	8.909091	0.000864
195.9	0.169134	70.168	8.934047	0.000866
196	0.169347	70.364	8.959002	0.000868
196.1	0.169529	70.56	8.983958	0.000869
196.2	0.16972	70.756	9.008913	0.000871
196.3	0.169888	70.952	9.033869	0.000873
196.4	0.170041	71.148	9.058824	0.000875
196.5	0.170237	71.344	9.083779	0.000877
196.6	0.170381	71.54	9.108735	0.000878
196.7	0.170556	71.736	9.13369	0.00088
196.8	0.17082	71.932	9.158646	0.000882
196.9	0.170918	72.128	9.183601	0.000883
197	0.171093	72.324	9.208557	0.000885
197.1	0.171363	72.52	9.233512	0.000888
197.2	0.171447	72.716	9.258467	0.000889
197.3	0.171631	72.912	9.283423	0.000891
197.4	0.171852	73.108	9.308378	0.000893
197.5	0.171976	73.304	9.333334	0.000894
197.6	0.172158	73.5	9.358289	0.000896
197.7	0.172332	73.696	9.383245	0.000898
197.8	0.172504	73.892	9.4082	0.000899
197.9	0.172715	74.088	9.433156	0.000901
198	0.172885	74.284	9.458111	0.000903

198.1	0.172998	74.48	9.483066	0.000904
198.2	0.173244	74.676	9.508022	0.000907
198.3	0.173385	74.872	9.532977	0.000908
198.4	0.173554	75.068	9.557933	0.00091
198.5	0.173742	75.264	9.582888	0.000912
198.6	0.173901	75.46	9.607844	0.000913
198.7	0.174062	75.656	9.632799	0.000915
198.8	0.17425	75.852	9.657754	0.000917
198.9	0.174435	76.048	9.68271	0.000919
199	0.174552	76.244	9.707665	0.00092
199.1	0.174726	76.44	9.732621	0.000921
199.2	0.174969	76.636	9.757576	0.000924
199.3	0.175121	76.832	9.782532	0.000925
199.4	0.175223	77.028	9.807487	0.000926
199.5	0.175426	77.224	9.832443	0.000928
199.6	0.175594	77.42	9.857398	0.00093
199.7	0.17574	77.616	9.882353	0.000932
199.8	0.175917	77.812	9.907309	0.000933
199.9	0.176108	78.008	9.932264	0.000935
200	0.176293	78.204	9.95722	0.000937
200.1	0.176481	78.4	9.982175	0.000939
200.2	0.176616	78.596	10.00713	0.00094
200.3	0.176802	78.792	10.03209	0.000942
200.4	0.176976	78.988	10.05704	0.000944
200.5	0.177134	79.184	10.082	0.000946
200.6	0.177233	79.38	10.10695	0.000947
200.7	0.177423	79.576	10.13191	0.000948
200.8	0.177632	79.772	10.15686	0.000951
200.9	0.177789	79.968	10.18182	0.000952
201	0.177932	80.164	10.20677	0.000954
201.1	0.17811	80.36	10.23173	0.000955
201.2	0.178275	80.556	10.25668	0.000957
201.3	0.178438	80.752	10.28164	0.000959
201.4	0.178582	80.948	10.3066	0.00096
201.5	0.178747	81.144	10.33155	0.000962
201.6	0.178906	81.34	10.35651	0.000963
201.7	0.179082	81.536	10.38146	0.000965
201.8	0.179249	81.732	10.40642	0.000967
201.9	0.17939	81.928	10.43137	0.000968
202	0.179571	82.124	10.45633	0.00097
202.1	0.179761	82.32	10.48128	0.000972
202.2	0.179943	82.516	10.50624	0.000974
202.3	0.180096	82.712	10.53119	0.000975
202.4	0.180253	82.908	10.55615	0.000977
202.5	0.180453	83.104	10.58111	0.000979
202.6	0.180619	83.3	10.60606	0.00098
202.7	0.180798	83.496	10.63102	0.000982
202.8	0.180996	83.692	10.65597	0.000984
202.9	0.18115	83.888	10.68093	0.000986
203	0.181285	84.084	10.70588	0.000987
203.1	0.181435	84.28	10.73084	0.000989
203.2	0.18165	84.476	10.75579	0.000991
203.3	0.181809	84.672	10.78075	0.000992
203.4	0.181929	84.868	10.8057	0.000993
203.5	0.182102	85.064	10.83066	0.000995

203.6	0.182278	85.26	10.85562	0.000997
203.7	0.182472	85.456	10.88057	0.000999
203.8	0.182618	85.652	10.90553	0.001
203.9	0.182758	85.848	10.93048	0.001002
204	0.182944	86.044	10.95544	0.001004
204.1	0.183101	86.24	10.98039	0.001005
204.2	0.18327	86.436	11.00535	0.001007
204.3	0.183417	86.632	11.0303	0.001008
204.4	0.183592	86.828	11.05526	0.00101
204.5	0.183755	87.024	11.08021	0.001012
204.6	0.183899	87.22	11.10517	0.001013
204.7	0.184063	87.416	11.13013	0.001015
204.8	0.184231	87.612	11.15508	0.001017
204.9	0.184402	87.808	11.18004	0.001018
205	0.184582	88.004	11.20499	0.00102
205.1	0.184747	88.2	11.22995	0.001022
205.2	0.184908	88.396	11.2549	0.001023
205.3	0.185066	88.592	11.27986	0.001025
205.4	0.185246	88.788	11.30481	0.001027
205.5	0.185425	88.984	11.32977	0.001028
205.6	0.185607	89.18	11.35472	0.00103
205.7	0.185745	89.376	11.37968	0.001032
205.8	0.185909	89.572	11.40464	0.001033
205.9	0.186068	89.768	11.42959	0.001035
206	0.186205	89.964	11.45455	0.001036
206.1	0.186384	90.16	11.4795	0.001038
206.2	0.186569	90.356	11.50446	0.00104
206.3	0.186701	90.552	11.52941	0.001041
206.4	0.186855	90.748	11.55437	0.001043
206.5	0.187065	90.944	11.57932	0.001045
206.6	0.187198	91.14	11.60428	0.001046
206.7	0.187382	91.336	11.62923	0.001048
206.8	0.187495	91.532	11.65419	0.001049
206.9	0.187656	91.728	11.67914	0.001051
207	0.187797	91.924	11.7041	0.001052
207.1	0.187979	92.12	11.72906	0.001054
207.2	0.188145	92.316	11.75401	0.001056
207.3	0.188287	92.512	11.77897	0.001057
207.4	0.188438	92.708	11.80392	0.001059
207.5	0.188598	92.904	11.82888	0.00106
207.6	0.188741	93.1	11.85383	0.001062
207.7	0.188895	93.296	11.87879	0.001063
207.8	0.189059	93.492	11.90374	0.001065
207.9	0.189269	93.688	11.9287	0.001067
208	0.189416	93.884	11.95365	0.001068
208.1	0.1896	94.08	11.97861	0.00107
208.2	0.189779	94.276	12.00357	0.001072
208.3	0.189926	94.472	12.02852	0.001073
208.4	0.190053	94.668	12.05348	0.001075
208.5	0.190211	94.864	12.07843	0.001076
208.6	0.190421	95.06	12.10339	0.001078
208.7	0.190591	95.256	12.12834	0.00108
208.8	0.190712	95.452	12.1533	0.001081
208.9	0.190886	95.648	12.17825	0.001083
209	0.191065	95.844	12.20321	0.001085

209.1	0.191223	96.04	12.22816	0.001086
209.2	0.191355	96.236	12.25312	0.001088
209.3	0.191494	96.432	12.27808	0.001089
209.4	0.19164	96.628	12.30303	0.001091
209.5	0.191835	96.824	12.32799	0.001093
209.6	0.191995	97.02	12.35294	0.001094
209.7	0.192118	97.216	12.3779	0.001095
209.8	0.192301	97.412	12.40285	0.001097
209.9	0.192468	97.608	12.42781	0.001099
210	0.192599	97.804	12.45276	0.0011
210.1	0.192746	98	12.47772	0.001102
210.2	0.192955	98.196	12.50267	0.001104
210.3	0.193132	98.392	12.52763	0.001106
210.4	0.19324	98.588	12.55259	0.001107
210.5	0.19343	98.784	12.57754	0.001109
210.6	0.193589	98.98	12.6025	0.00111
210.7	0.1938	99.176	12.62745	0.001112
210.8	0.193952	99.372	12.65241	0.001114
210.9	0.194112	99.568	12.67736	0.001115
211	0.194271	99.764	12.70232	0.001117
211.1	0.194446	99.96	12.72727	0.001119
211.2	0.194586	100.156	12.75223	0.00112
211.3	0.194778	100.352	12.77718	0.001122
211.4	0.194919	100.548	12.80214	0.001123
211.5	0.195071	100.744	12.8271	0.001125
211.6	0.195288	100.94	12.85205	0.001127
211.7	0.195422	101.136	12.87701	0.001128
211.8	0.195563	101.332	12.90196	0.00113
211.9	0.195767	101.528	12.92692	0.001132
212	0.195872	101.724	12.95187	0.001133
212.1	0.19604	101.92	12.97683	0.001135
212.2	0.196209	102.116	13.00178	0.001136
212.3	0.19634	102.312	13.02674	0.001138
212.4	0.196513	102.508	13.05169	0.001139
212.5	0.196662	102.704	13.07665	0.001141
212.6	0.196838	102.9	13.1016	0.001143
212.7	0.196984	103.096	13.12656	0.001144
212.8	0.197167	103.292	13.15152	0.001146
212.9	0.19732	103.488	13.17647	0.001147
213	0.197525	103.684	13.20143	0.001149
213.1	0.19768	103.88	13.22638	0.001151
213.2	0.197828	104.076	13.25134	0.001152
213.3	0.197982	104.272	13.27629	0.001154
213.4	0.198151	104.468	13.30125	0.001156

B.1.10 Elastic Modulus test results of SFRGC(Na) at 800⁰C temperature.

Time	Absolute	Force	Stress	Strain
147.3	0.251929	0	0	0
147.4	0.252611	0.196	0.024955	6.83E-06
147.5	0.25325	0.392	0.049911	1.32E-05
147.6	0.25383	0.588	0.074866	1.9E-05
147.7	0.25445	0.784	0.099822	2.52E-05
147.8	0.255125	0.98	0.124777	3.2E-05
147.9	0.255811	1.176	0.149733	3.88E-05
148	0.256454	1.372	0.174688	4.53E-05
148.1	0.257112	1.568	0.199644	5.18E-05
148.2	0.257832	1.764	0.224599	5.9E-05
148.3	0.258505	1.96	0.249554	6.58E-05
148.4	0.259096	2.156	0.27451	7.17E-05
148.5	0.259698	2.352	0.299465	7.77E-05
148.6	0.260395	2.548	0.324421	8.47E-05
148.7	0.26102	2.744	0.349376	9.09E-05
148.8	0.261664	2.94	0.374332	9.74E-05
148.9	0.262331	3.136	0.399287	0.000104
149	0.262996	3.332	0.424242	0.000111
149.1	0.263634	3.528	0.449198	0.000117
149.2	0.264332	3.724	0.474153	0.000124
149.3	0.26501	3.92	0.499109	0.000131
149.4	0.265703	4.116	0.524064	0.000138
149.5	0.266358	4.312	0.54902	0.000144
149.6	0.266977	4.508	0.573975	0.00015
149.7	0.267669	4.704	0.598931	0.000157
149.8	0.268283	4.9	0.623886	0.000164
149.9	0.268911	5.096	0.648841	0.00017
150	0.269599	5.292	0.673797	0.000177
150.1	0.270211	5.488	0.698752	0.000183
150.2	0.270977	5.684	0.723708	0.00019
150.3	0.271611	5.88	0.748663	0.000197
150.4	0.272282	6.076	0.773619	0.000204
150.5	0.272961	6.272	0.798574	0.00021
150.6	0.273557	6.468	0.823529	0.000216
150.7	0.2742	6.664	0.848485	0.000223
150.8	0.274824	6.86	0.87344	0.000229
150.9	0.275444	7.056	0.898396	0.000235
151	0.276014	7.252	0.923351	0.000241
151.1	0.276671	7.448	0.948307	0.000247
151.2	0.277339	7.644	0.973262	0.000254
151.3	0.277911	7.84	0.998218	0.00026
151.4	0.27857	8.036	1.023173	0.000266
151.5	0.279291	8.232	1.048128	0.000274
151.6	0.279832	8.428	1.073084	0.000279
151.7	0.280408	8.624	1.098039	0.000285
151.8	0.281092	8.82	1.122995	0.000292
151.9	0.281678	9.016	1.14795	0.000297
152	0.282223	9.212	1.172906	0.000303
152.1	0.282884	9.408	1.197861	0.00031
152.2	0.283495	9.604	1.222816	0.000316

152.3	0.284084	9.8	1.247772	0.000322
152.4	0.284595	9.996	1.272727	0.000327
152.5	0.285275	10.192	1.297683	0.000333
152.6	0.285976	10.388	1.322638	0.00034
152.7	0.286517	10.584	1.347594	0.000346
152.8	0.287103	10.78	1.372549	0.000352
152.9	0.287667	10.976	1.397505	0.000357
153	0.288275	11.172	1.42246	0.000363
153.1	0.288894	11.368	1.447415	0.00037
153.2	0.289369	11.564	1.472371	0.000374
153.3	0.289914	11.76	1.497326	0.00038
153.4	0.290523	11.956	1.522282	0.000386
153.5	0.291076	12.152	1.547237	0.000391
153.6	0.291656	12.348	1.572193	0.000397
153.7	0.292218	12.544	1.597148	0.000403
153.8	0.292868	12.74	1.622103	0.000409
153.9	0.293465	12.936	1.647059	0.000415
154	0.29397	13.132	1.672014	0.00042
154.1	0.29452	13.328	1.69697	0.000426
154.2	0.295062	13.524	1.721925	0.000431
154.3	0.295621	13.72	1.746881	0.000437
154.4	0.296333	13.916	1.771836	0.000444
154.5	0.296936	14.112	1.796792	0.00045
154.6	0.297459	14.308	1.821747	0.000455
154.7	0.297997	14.504	1.846702	0.000461
154.8	0.298609	14.7	1.871658	0.000467
154.9	0.299227	14.896	1.896613	0.000473
155	0.299721	15.092	1.921569	0.000478
155.1	0.300234	15.288	1.946524	0.000483
155.2	0.300729	15.484	1.97148	0.000488
155.3	0.30131	15.68	1.996435	0.000494
155.4	0.302034	15.876	2.02139	0.000501
155.5	0.302522	16.072	2.046346	0.000506
155.6	0.302983	16.268	2.071301	0.000511
155.7	0.303606	16.464	2.096257	0.000517
155.8	0.304217	16.66	2.121212	0.000523
155.9	0.304753	16.856	2.146168	0.000528
156	0.305208	17.052	2.171123	0.000533
156.1	0.305679	17.248	2.196079	0.000538
156.2	0.306214	17.444	2.221034	0.000543
156.3	0.30673	17.64	2.245989	0.000548
156.4	0.307393	17.836	2.270945	0.000555
156.5	0.307916	18.032	2.2959	0.00056
156.6	0.308295	18.228	2.320856	0.000564
156.7	0.308836	18.424	2.345811	0.000569
156.8	0.309364	18.62	2.370767	0.000574
156.9	0.30996	18.816	2.395722	0.00058
157	0.310515	19.012	2.420677	0.000586
157.1	0.310956	19.208	2.445633	0.00059
157.2	0.311422	19.404	2.470588	0.000595
157.3	0.311884	19.6	2.495544	0.0006
157.4	0.3125	19.796	2.520499	0.000606
157.5	0.313011	19.992	2.545455	0.000611
157.6	0.313391	20.188	2.57041	0.000615
157.7	0.313909	20.384	2.595366	0.00062

157.8	0.314472	20.58	2.620321	0.000625
157.9	0.314863	20.776	2.645276	0.000629
158	0.315375	20.972	2.670232	0.000634
158.1	0.315873	21.168	2.695187	0.000639
158.2	0.316196	21.364	2.720143	0.000643
158.3	0.316743	21.56	2.745098	0.000648
158.4	0.317216	21.756	2.770054	0.000653
158.5	0.31769	21.952	2.795009	0.000658
158.6	0.31814	22.148	2.819964	0.000662
158.7	0.318607	22.344	2.84492	0.000667
158.8	0.319094	22.54	2.869875	0.000672
158.9	0.319568	22.736	2.894831	0.000676
159	0.319994	22.932	2.919786	0.000681
159.1	0.320536	23.128	2.944742	0.000686
159.2	0.321048	23.324	2.969697	0.000691
159.3	0.321449	23.52	2.994653	0.000695
159.4	0.321931	23.716	3.019608	0.0007
159.5	0.322402	23.912	3.044563	0.000705
159.6	0.322851	24.108	3.069519	0.000709
159.7	0.323336	24.304	3.094474	0.000714
159.8	0.323762	24.5	3.11943	0.000718
159.9	0.324348	24.696	3.144385	0.000724
160	0.32481	24.892	3.169341	0.000729
160.1	0.325248	25.088	3.194296	0.000733
160.2	0.325723	25.284	3.219251	0.000738
160.3	0.326133	25.48	3.244207	0.000742
160.4	0.32659	25.676	3.269162	0.000747
160.5	0.327038	25.872	3.294118	0.000751
160.6	0.327487	26.068	3.319073	0.000756
160.7	0.32786	26.264	3.344029	0.000759
160.8	0.328212	26.46	3.368984	0.000763
160.9	0.328654	26.656	3.39394	0.000767
161	0.329181	26.852	3.418895	0.000773
161.1	0.329652	27.048	3.44385	0.000777
161.2	0.330086	27.244	3.468806	0.000782
161.3	0.330515	27.44	3.493761	0.000786
161.4	0.330975	27.636	3.518717	0.00079
161.5	0.331382	27.832	3.543672	0.000795
161.6	0.331803	28.028	3.568628	0.000799
161.7	0.332199	28.224	3.593583	0.000803
161.8	0.332681	28.42	3.618538	0.000808
161.9	0.333088	28.616	3.643494	0.000812
162	0.333474	28.812	3.668449	0.000815
162.1	0.334016	29.008	3.693405	0.000821
162.2	0.33445	29.204	3.71836	0.000825
162.3	0.334854	29.4	3.743316	0.000829
162.4	0.335242	29.596	3.768271	0.000833
162.5	0.335763	29.792	3.793227	0.000838
162.6	0.336169	29.988	3.818182	0.000842
162.7	0.336436	30.184	3.843137	0.000845
162.8	0.336914	30.38	3.868093	0.00085
162.9	0.337406	30.576	3.893048	0.000855
163	0.337822	30.772	3.918004	0.000859
163.1	0.338224	30.968	3.942959	0.000863
163.2	0.338669	31.164	3.967915	0.000867

163.3	0.339104	31.36	3.99287	0.000872
163.4	0.339534	31.556	4.017826	0.000876
163.5	0.339908	31.752	4.042781	0.00088
163.6	0.340306	31.948	4.067736	0.000884
163.7	0.340802	32.144	4.092692	0.000889
163.8	0.341232	32.34	4.117647	0.000893
163.9	0.341605	32.536	4.142603	0.000897
164	0.342062	32.732	4.167558	0.000901
164.1	0.342427	32.928	4.192514	0.000905
164.2	0.342827	33.124	4.217469	0.000909
164.3	0.343235	33.32	4.242424	0.000913
164.4	0.343667	33.516	4.26738	0.000917
164.5	0.344059	33.712	4.292335	0.000921
164.6	0.344486	33.908	4.317291	0.000926
164.7	0.34487	34.104	4.342246	0.000929
164.8	0.345271	34.3	4.367202	0.000933
164.9	0.345649	34.496	4.392157	0.000937
165	0.345951	34.692	4.417113	0.00094
165.1	0.346429	34.888	4.442068	0.000945
165.2	0.346796	35.084	4.467023	0.000949
165.3	0.34718	35.28	4.491979	0.000953
165.4	0.347595	35.476	4.516934	0.000957
165.5	0.347953	35.672	4.54189	0.00096
165.6	0.348395	35.868	4.566845	0.000965
165.7	0.348817	36.064	4.591801	0.000969
165.8	0.349233	36.26	4.616756	0.000973
165.9	0.349586	36.456	4.641711	0.000977
166	0.350068	36.652	4.666667	0.000981
166.1	0.350394	36.848	4.691622	0.000985
166.2	0.350761	37.044	4.716578	0.000988
166.3	0.351144	37.24	4.741533	0.000992
166.4	0.351543	37.436	4.766489	0.000996
166.5	0.35198	37.632	4.791444	0.001001
166.6	0.352275	37.828	4.8164	0.001003
166.7	0.352657	38.024	4.841355	0.001007
166.8	0.35302	38.22	4.86631	0.001011
166.9	0.353434	38.416	4.891266	0.001015
167	0.353831	38.612	4.916221	0.001019
167.1	0.354218	38.808	4.941177	0.001023
167.2	0.354557	39.004	4.966132	0.001026
167.3	0.35493	39.2	4.991088	0.00103
167.4	0.355361	39.396	5.016043	0.001034
167.5	0.355734	39.592	5.040998	0.001038
167.6	0.356113	39.788	5.065954	0.001042
167.7	0.356507	39.984	5.090909	0.001046
167.8	0.356886	40.18	5.115865	0.00105
167.9	0.357337	40.376	5.14082	0.001054
168	0.357671	40.572	5.165776	0.001057
168.1	0.357911	40.768	5.190731	0.00106
168.2	0.358406	40.964	5.215687	0.001065
168.3	0.358764	41.16	5.240642	0.001068
168.4	0.359145	41.356	5.265597	0.001072
168.5	0.359476	41.552	5.290553	0.001075
168.6	0.359928	41.748	5.315508	0.00108
168.7	0.360264	41.944	5.340464	0.001083

168.8	0.36067	42.14	5.365419	0.001087
168.9	0.360928	42.336	5.390375	0.00109
169	0.361461	42.532	5.41533	0.001095
169.1	0.361723	42.728	5.440285	0.001098
169.2	0.362169	42.924	5.465241	0.001102
169.3	0.362419	43.12	5.490196	0.001105
169.4	0.362799	43.316	5.515152	0.001109
169.5	0.363182	43.512	5.540107	0.001113
169.6	0.363424	43.708	5.565063	0.001115
169.7	0.363915	43.904	5.590018	0.00112
169.8	0.364446	44.1	5.614974	0.001125
169.9	0.364697	44.296	5.639929	0.001128
170	0.365072	44.492	5.664884	0.001131
170.1	0.365481	44.688	5.68984	0.001136
170.2	0.365733	44.884	5.714795	0.001138
170.3	0.36623	45.08	5.739751	0.001143
170.4	0.366474	45.276	5.764706	0.001145
170.5	0.366819	45.472	5.789662	0.001149
170.6	0.367252	45.668	5.814617	0.001153
170.7	0.367417	45.864	5.839572	0.001155
170.8	0.367633	46.06	5.864528	0.001157
170.9	0.367981	46.256	5.889483	0.001161
171	0.368645	46.452	5.914439	0.001167
171.1	0.369188	46.648	5.939394	0.001173
171.2	0.369358	46.844	5.96435	0.001174
171.3	0.369824	47.04	5.989305	0.001179
171.4	0.370237	47.236	6.014261	0.001183
171.5	0.370387	47.432	6.039216	0.001185
171.6	0.370768	47.628	6.064171	0.001188
171.7	0.371192	47.824	6.089127	0.001193
171.8	0.371687	48.02	6.114082	0.001198
171.9	0.371837	48.216	6.139038	0.001199
172	0.372028	48.412	6.163993	0.001201
172.1	0.372313	48.608	6.188949	0.001204
172.2	0.372919	48.804	6.213904	0.00121
172.3	0.373461	49	6.238859	0.001215
172.4	0.373661	49.196	6.263815	0.001217
172.5	0.373746	49.392	6.28877	0.001218
172.6	0.374074	49.588	6.313726	0.001221
172.7	0.374634	49.784	6.338681	0.001227
172.8	0.374971	49.98	6.363637	0.00123
172.9	0.375207	50.176	6.388592	0.001233
173	0.375734	50.372	6.413548	0.001238
173.1	0.37621	50.568	6.438503	0.001243
173.2	0.3766	50.764	6.463458	0.001247
173.3	0.377032	50.96	6.488414	0.001251
173.4	0.37713	51.156	6.513369	0.001252
173.5	0.37724	51.352	6.538325	0.001253
173.6	0.377754	51.548	6.56328	0.001258

B.1.11 Elastic Modulus test results of SFRGC(K) at ambient temperature.

Time	Absolute	Force	Stress	Strain
185.3	0.039806	0	0	0
185.4	0.039932	0.196	0.024955	1.26E-06
185.5	0.04008	0.392	0.049911	2.74E-06
185.6	0.040212	0.588	0.074866	4.05E-06
185.7	0.040353	0.784	0.099822	5.47E-06
185.8	0.040492	0.98	0.124777	6.86E-06
185.9	0.040633	1.176	0.149733	8.27E-06
186	0.040793	1.372	0.174688	9.87E-06
186.1	0.040935	1.568	0.199644	1.13E-05
186.2	0.041072	1.764	0.224599	1.27E-05
186.3	0.041173	1.96	0.249554	1.37E-05
186.4	0.041332	2.156	0.27451	1.53E-05
186.5	0.041489	2.352	0.299465	1.68E-05
186.6	0.041602	2.548	0.324421	1.8E-05
186.7	0.041766	2.744	0.349376	1.96E-05
186.8	0.041911	2.94	0.374332	2.11E-05
186.9	0.042066	3.136	0.399287	2.26E-05
187	0.042235	3.332	0.424242	2.43E-05
187.1	0.042345	3.528	0.449198	2.54E-05
187.2	0.042509	3.724	0.474153	2.7E-05
187.3	0.042657	3.92	0.499109	2.85E-05
187.4	0.042759	4.116	0.524064	2.95E-05
187.5	0.042914	4.312	0.54902	3.11E-05
187.6	0.043046	4.508	0.573975	3.24E-05
187.7	0.043211	4.704	0.598931	3.4E-05
187.8	0.043356	4.9	0.623886	3.55E-05
187.9	0.043483	5.096	0.648841	3.68E-05
188	0.043645	5.292	0.673797	3.84E-05
188.1	0.043811	5.488	0.698752	4E-05
188.2	0.043955	5.684	0.723708	4.15E-05
188.3	0.044132	5.88	0.748663	4.33E-05
188.4	0.044234	6.076	0.773619	4.43E-05
188.5	0.044376	6.272	0.798574	4.57E-05
188.6	0.044523	6.468	0.823529	4.72E-05
188.7	0.04465	6.664	0.848485	4.84E-05
188.8	0.044845	6.86	0.87344	5.04E-05
188.9	0.045022	7.056	0.898396	5.22E-05
189	0.045098	7.252	0.923351	5.29E-05
189.1	0.045274	7.448	0.948307	5.47E-05
189.2	0.045424	7.644	0.973262	5.62E-05
189.3	0.045553	7.84	0.998218	5.75E-05
189.4	0.045686	8.036	1.023173	5.88E-05
189.5	0.045825	8.232	1.048128	6.02E-05
189.6	0.045952	8.428	1.073084	6.15E-05
189.7	0.046089	8.624	1.098039	6.28E-05
189.8	0.046206	8.82	1.122995	6.4E-05
189.9	0.046392	9.016	1.14795	6.59E-05
190	0.046557	9.212	1.172906	6.75E-05
190.1	0.046671	9.408	1.197861	6.86E-05
190.2	0.046844	9.604	1.222816	7.04E-05

190.3	0.047016	9.8	1.247772	7.21E-05
190.4	0.047145	9.996	1.272727	7.34E-05
190.5	0.047255	10.192	1.297683	7.45E-05
190.6	0.047394	10.388	1.322638	7.59E-05
190.7	0.047611	10.584	1.347594	7.81E-05
190.8	0.047781	10.78	1.372549	7.97E-05
190.9	0.04792	10.976	1.397505	8.11E-05
191	0.048045	11.172	1.42246	8.24E-05
191.1	0.048185	11.368	1.447415	8.38E-05
191.2	0.048322	11.564	1.472371	8.52E-05
191.3	0.048463	11.76	1.497326	8.66E-05
191.4	0.048582	11.956	1.522282	8.78E-05
191.5	0.048714	12.152	1.547237	8.91E-05
191.6	0.048888	12.348	1.572193	9.08E-05
191.7	0.048985	12.544	1.597148	9.18E-05
191.8	0.049129	12.74	1.622103	9.32E-05
191.9	0.049264	12.936	1.647059	9.46E-05
192	0.049423	13.132	1.672014	9.62E-05
192.1	0.04958	13.328	1.69697	9.77E-05
192.2	0.049711	13.524	1.721925	9.9E-05
192.3	0.049818	13.72	1.746881	0.0001
192.4	0.050023	13.916	1.771836	0.000102
192.5	0.050131	14.112	1.796792	0.000103
192.6	0.050267	14.308	1.821747	0.000105
192.7	0.050378	14.504	1.846702	0.000106
192.8	0.050538	14.7	1.871658	0.000107
192.9	0.050741	14.896	1.896613	0.000109
193	0.050839	15.092	1.921569	0.00011
193.1	0.050922	15.288	1.946524	0.000111
193.2	0.051111	15.484	1.97148	0.000113
193.3	0.051208	15.68	1.996435	0.000114
193.4	0.051375	15.876	2.02139	0.000116
193.5	0.051553	16.072	2.046346	0.000117
193.6	0.051693	16.268	2.071301	0.000119
193.7	0.051769	16.464	2.096257	0.00012
193.8	0.05188	16.66	2.121212	0.000121
193.9	0.052095	16.856	2.146168	0.000123
194	0.052251	17.052	2.171123	0.000124
194.1	0.052331	17.248	2.196079	0.000125
194.2	0.05242	17.444	2.221034	0.000126
194.3	0.05256	17.64	2.245989	0.000128
194.4	0.052743	17.836	2.270945	0.000129
194.5	0.052878	18.032	2.2959	0.000131
194.6	0.052988	18.228	2.320856	0.000132
194.7	0.053096	18.424	2.345811	0.000133
194.8	0.053231	18.62	2.370767	0.000134
194.9	0.053393	18.816	2.395722	0.000136
195	0.053536	19.012	2.420677	0.000137
195.1	0.053662	19.208	2.445633	0.000139
195.2	0.053787	19.404	2.470588	0.00014
195.3	0.053912	19.6	2.495544	0.000141
195.4	0.054058	19.796	2.520499	0.000143
195.5	0.054248	19.992	2.545455	0.000144
195.6	0.054349	20.188	2.57041	0.000145
195.7	0.054474	20.384	2.595366	0.000147

195.8	0.054585	20.58	2.620321	0.000148
195.9	0.054694	20.776	2.645276	0.000149
196	0.054879	20.972	2.670232	0.000151
196.1	0.05506	21.168	2.695187	0.000153
196.2	0.055132	21.364	2.720143	0.000153
196.3	0.055211	21.56	2.745098	0.000154
196.4	0.055376	21.756	2.770054	0.000156
196.5	0.055565	21.952	2.795009	0.000158
196.6	0.055656	22.148	2.819964	0.000158
196.7	0.055711	22.344	2.84492	0.000159
196.8	0.055864	22.54	2.869875	0.000161
196.9	0.056031	22.736	2.894831	0.000162
197	0.056169	22.932	2.919786	0.000164
197.1	0.056262	23.128	2.944742	0.000165
197.2	0.056398	23.324	2.969697	0.000166
197.3	0.056555	23.52	2.994653	0.000167
197.4	0.056677	23.716	3.019608	0.000169
197.5	0.056834	23.912	3.044563	0.00017
197.6	0.056974	24.108	3.069519	0.000172
197.7	0.057023	24.304	3.094474	0.000172
197.8	0.057151	24.5	3.11943	0.000173
197.9	0.057356	24.696	3.144385	0.000175
198	0.057487	24.892	3.169341	0.000177
198.1	0.057583	25.088	3.194296	0.000178
198.2	0.057745	25.284	3.219251	0.000179
198.3	0.057863	25.48	3.244207	0.000181
198.4	0.057946	25.676	3.269162	0.000181
198.5	0.058064	25.872	3.294118	0.000183
198.6	0.058229	26.068	3.319073	0.000184
198.7	0.058362	26.264	3.344029	0.000186
198.8	0.058451	26.46	3.368984	0.000186
198.9	0.058607	26.656	3.39394	0.000188
199	0.058767	26.852	3.418895	0.00019
199.1	0.058916	27.048	3.44385	0.000191
199.2	0.059003	27.244	3.468806	0.000192
199.3	0.059126	27.44	3.493761	0.000193
199.4	0.059282	27.636	3.518717	0.000195
199.5	0.059416	27.832	3.543672	0.000196
199.6	0.059538	28.028	3.568628	0.000197
199.7	0.059617	28.224	3.593583	0.000198
199.8	0.059717	28.42	3.618538	0.000199
199.9	0.059879	28.616	3.643494	0.000201
200	0.06005	28.812	3.668449	0.000202
200.1	0.060167	29.008	3.693405	0.000204
200.2	0.060287	29.204	3.71836	0.000205
200.3	0.060399	29.4	3.743316	0.000206
200.4	0.060553	29.596	3.768271	0.000207
200.5	0.060637	29.792	3.793227	0.000208
200.6	0.060782	29.988	3.818182	0.00021
200.7	0.060945	30.184	3.843137	0.000211
200.8	0.06102	30.38	3.868093	0.000212
200.9	0.061155	30.576	3.893048	0.000213
201	0.06131	30.772	3.918004	0.000215
201.1	0.061419	30.968	3.942959	0.000216
201.2	0.061516	31.164	3.967915	0.000217

201.3	0.061686	31.36	3.99287	0.000219
201.4	0.061826	31.556	4.017826	0.00022
201.5	0.061928	31.752	4.042781	0.000221
201.6	0.062059	31.948	4.067736	0.000223
201.7	0.062184	32.144	4.092692	0.000224
201.8	0.06232	32.34	4.117647	0.000225
201.9	0.062434	32.536	4.142603	0.000226
202	0.062534	32.732	4.167558	0.000227
202.1	0.062649	32.928	4.192514	0.000228
202.2	0.062796	33.124	4.217469	0.00023
202.3	0.062952	33.32	4.242424	0.000231
202.4	0.063059	33.516	4.26738	0.000233
202.5	0.063201	33.712	4.292335	0.000234
202.6	0.063309	33.908	4.317291	0.000235
202.7	0.063416	34.104	4.342246	0.000236
202.8	0.063534	34.3	4.367202	0.000237
202.9	0.063667	34.496	4.392157	0.000239
203	0.063785	34.692	4.417113	0.00024
203.1	0.063879	34.888	4.442068	0.000241
203.2	0.063976	35.084	4.467023	0.000242
203.3	0.064101	35.28	4.491979	0.000243
203.4	0.064267	35.476	4.516934	0.000245
203.5	0.064406	35.672	4.54189	0.000246
203.6	0.06451	35.868	4.566845	0.000247
203.7	0.064644	36.064	4.591801	0.000248
203.8	0.064759	36.26	4.616756	0.00025
203.9	0.064882	36.456	4.641711	0.000251
204	0.064982	36.652	4.666667	0.000252
204.1	0.065119	36.848	4.691622	0.000253
204.2	0.065254	37.044	4.716578	0.000254
204.3	0.065422	37.24	4.741533	0.000256
204.4	0.065507	37.436	4.766489	0.000257
204.5	0.06562	37.632	4.791444	0.000258
204.6	0.065771	37.828	4.8164	0.00026
204.7	0.065894	38.024	4.841355	0.000261
204.8	0.066045	38.22	4.86631	0.000262
204.9	0.066157	38.416	4.891266	0.000264
205	0.066282	38.612	4.916221	0.000265
205.1	0.066398	38.808	4.941177	0.000266
205.2	0.066509	39.004	4.966132	0.000267
205.3	0.06661	39.2	4.991088	0.000268
205.4	0.066748	39.396	5.016043	0.000269
205.5	0.066815	39.592	5.040998	0.00027
205.6	0.067019	39.788	5.065954	0.000272
205.7	0.067101	39.984	5.090909	0.000273
205.8	0.067245	40.18	5.115865	0.000274
205.9	0.067343	40.376	5.14082	0.000275
206	0.067468	40.572	5.165776	0.000277
206.1	0.06763	40.768	5.190731	0.000278
206.2	0.067748	40.964	5.215687	0.000279
206.3	0.067862	41.16	5.240642	0.000281
206.4	0.067994	41.356	5.265597	0.000282
206.5	0.068068	41.552	5.290553	0.000283
206.6	0.068189	41.748	5.315508	0.000284
206.7	0.068351	41.944	5.340464	0.000285

206.8	0.068474	42.14	5.365419	0.000287
206.9	0.068575	42.336	5.390375	0.000288
207	0.068738	42.532	5.41533	0.000289
207.1	0.06885	42.728	5.440285	0.00029
207.2	0.068922	42.924	5.465241	0.000291
207.3	0.069064	43.12	5.490196	0.000293
207.4	0.069118	43.316	5.515152	0.000293
207.5	0.069301	43.512	5.540107	0.000295
207.6	0.069413	43.708	5.565063	0.000296
207.7	0.069536	43.904	5.590018	0.000297
207.8	0.069652	44.1	5.614974	0.000298
207.9	0.069752	44.296	5.639929	0.000299
208	0.069881	44.492	5.664884	0.000301
208.1	0.069978	44.688	5.68984	0.000302
208.2	0.070156	44.884	5.714795	0.000304
208.3	0.070248	45.08	5.739751	0.000304
208.4	0.070375	45.276	5.764706	0.000306
208.5	0.070444	45.472	5.789662	0.000306
208.6	0.070622	45.668	5.814617	0.000308
208.7	0.070659	45.864	5.839572	0.000309
208.8	0.070843	46.06	5.864528	0.00031
208.9	0.070948	46.256	5.889483	0.000311
209	0.071084	46.452	5.914439	0.000313
209.1	0.071264	46.648	5.939394	0.000315
209.2	0.071308	46.844	5.96435	0.000315
209.3	0.071402	47.04	5.989305	0.000316
209.4	0.071582	47.236	6.014261	0.000318
209.5	0.07176	47.432	6.039216	0.00032
209.6	0.071829	47.628	6.064171	0.00032
209.7	0.071875	47.824	6.089127	0.000321
209.8	0.072055	48.02	6.114082	0.000322
209.9	0.072249	48.216	6.139038	0.000324
210	0.07229	48.412	6.163993	0.000325
210.1	0.072379	48.608	6.188949	0.000326
210.2	0.07254	48.804	6.213904	0.000327
210.3	0.072738	49	6.238859	0.000329
210.4	0.072785	49.196	6.263815	0.00033
210.5	0.072848	49.392	6.28877	0.00033
210.6	0.072964	49.588	6.313726	0.000332
210.7	0.073043	49.784	6.338681	0.000332
210.8	0.07315	49.98	6.363637	0.000333
210.9	0.073381	50.176	6.388592	0.000336
211	0.073561	50.372	6.413548	0.000338
211.1	0.073611	50.568	6.438503	0.000338
211.2	0.073827	50.764	6.463458	0.00034
211.3	0.073893	50.96	6.488414	0.000341
211.4	0.073906	51.156	6.513369	0.000341
211.5	0.074034	51.352	6.538325	0.000342
211.6	0.074107	51.548	6.56328	0.000343
211.7	0.07417	51.744	6.588236	0.000344
211.8	0.074335	51.94	6.613191	0.000345
211.9	0.074628	52.136	6.638146	0.000348
212	0.074635	52.332	6.663102	0.000348
212.1	0.074685	52.528	6.688057	0.000349
212.2	0.074778	52.724	6.713013	0.00035

212.3	0.07491	52.92	6.737968	0.000351
212.4	0.075152	53.116	6.762924	0.000353
212.5	0.075274	53.312	6.787879	0.000355
212.6	0.075251	53.508	6.812835	0.000354
212.7	0.075373	53.704	6.83779	0.000356
212.8	0.075628	53.9	6.862745	0.000358
212.9	0.075761	54.096	6.887701	0.00036
213	0.07581	54.292	6.912656	0.00036
213.1	0.075852	54.488	6.937612	0.00036
213.2	0.076062	54.684	6.962567	0.000363
213.3	0.076108	54.88	6.987523	0.000363
213.4	0.076287	55.076	7.012478	0.000365
213.5	0.076429	55.272	7.037433	0.000366
213.6	0.076486	55.468	7.062389	0.000367
213.7	0.076575	55.664	7.087344	0.000368
213.8	0.076784	55.86	7.1123	0.00037

B.1.12 Elastic Modulus test results of SFRGC(K) at 200℃ temperature.

Time	Absolute	Force	Stress	Strain
208.2	0.055508	0	0	0
208.3	0.0557	0.196	0.024955	1.91E-06
208.4	0.055867	0.392	0.049911	3.59E-06
208.5	0.055995	0.588	0.074866	4.87E-06
208.6	0.056122	0.784	0.099822	6.14E-06
208.7	0.056308	0.98	0.124777	8E-06
208.8	0.056491	1.176	0.149733	9.83E-06
208.9	0.056655	1.372	0.174688	1.15E-05
209	0.056817	1.568	0.199644	1.31E-05
209.1	0.057009	1.764	0.224599	1.5E-05
209.2	0.057173	1.96	0.249554	1.66E-05
209.3	0.057321	2.156	0.27451	1.81E-05
209.4	0.057507	2.352	0.299465	2E-05
209.5	0.057718	2.548	0.324421	2.21E-05
209.6	0.057856	2.744	0.349376	2.35E-05
209.7	0.058005	2.94	0.374332	2.5E-05
209.8	0.058189	3.136	0.399287	2.68E-05
209.9	0.058354	3.332	0.424242	2.85E-05
210	0.058524	3.528	0.449198	3.02E-05
210.1	0.058678	3.724	0.474153	3.17E-05
210.2	0.058808	3.92	0.499109	3.3E-05
210.3	0.058964	4.116	0.524064	3.46E-05
210.4	0.059159	4.312	0.54902	3.65E-05
210.5	0.059294	4.508	0.573975	3.79E-05
210.6	0.059453	4.704	0.598931	3.94E-05
210.7	0.059591	4.9	0.623886	4.08E-05
210.8	0.059747	5.096	0.648841	4.24E-05
210.9	0.059912	5.292	0.673797	4.4E-05
211	0.06008	5.488	0.698752	4.57E-05
211.1	0.060266	5.684	0.723708	4.76E-05

211.2	0.060412	5.88	0.748663	4.9E-05
211.3	0.060595	6.076	0.773619	5.09E-05
211.4	0.060783	6.272	0.798574	5.27E-05
211.5	0.060957	6.468	0.823529	5.45E-05
211.6	0.061151	6.664	0.848485	5.64E-05
211.7	0.061304	6.86	0.87344	5.8E-05
211.8	0.061438	7.056	0.898396	5.93E-05
211.9	0.061539	7.252	0.923351	6.03E-05
212	0.061697	7.448	0.948307	6.19E-05
212.1	0.061862	7.644	0.973262	6.35E-05
212.2	0.062081	7.84	0.998218	6.57E-05
212.3	0.062251	8.036	1.023173	6.74E-05
212.4	0.062397	8.232	1.048128	6.89E-05
212.5	0.062564	8.428	1.073084	7.06E-05
212.6	0.062701	8.624	1.098039	7.19E-05
212.7	0.062854	8.82	1.122995	7.35E-05
212.8	0.063027	9.016	1.14795	7.52E-05
212.9	0.063207	9.212	1.172906	7.7E-05
213	0.063367	9.408	1.197861	7.86E-05
213.1	0.063533	9.604	1.222816	8.03E-05
213.2	0.063668	9.8	1.247772	8.16E-05
213.3	0.063853	9.996	1.272727	8.34E-05
213.4	0.064067	10.192	1.297683	8.56E-05
213.5	0.064209	10.388	1.322638	8.7E-05
213.6	0.064401	10.584	1.347594	8.89E-05
213.7	0.064553	10.78	1.372549	9.04E-05
213.8	0.064699	10.976	1.397505	9.19E-05
213.9	0.064834	11.172	1.42246	9.33E-05
214	0.065027	11.368	1.447415	9.52E-05
214.1	0.065198	11.564	1.472371	9.69E-05
214.2	0.065326	11.76	1.497326	9.82E-05
214.3	0.065448	11.956	1.522282	9.94E-05
214.4	0.06564	12.152	1.547237	0.000101
214.5	0.065823	12.348	1.572193	0.000103
214.6	0.065985	12.544	1.597148	0.000105
214.7	0.066159	12.74	1.622103	0.000107
214.8	0.066256	12.936	1.647059	0.000107
214.9	0.066392	13.132	1.672014	0.000109
215	0.066549	13.328	1.69697	0.00011
215.1	0.066695	13.524	1.721925	0.000112
215.2	0.066886	13.72	1.746881	0.000114
215.3	0.067064	13.916	1.771836	0.000116
215.4	0.067178	14.112	1.796792	0.000117
215.5	0.067325	14.308	1.821747	0.000118
215.6	0.067515	14.504	1.846702	0.00012
215.7	0.067678	14.7	1.871658	0.000122
215.8	0.067843	14.896	1.896613	0.000123
215.9	0.067978	15.092	1.921569	0.000125
216	0.068122	15.288	1.946524	0.000126
216.1	0.068274	15.484	1.97148	0.000128
216.2	0.068425	15.68	1.996435	0.000129
216.3	0.068597	15.876	2.02139	0.000131
216.4	0.068708	16.072	2.046346	0.000132
216.5	0.06889	16.268	2.071301	0.000134
216.6	0.069051	16.464	2.096257	0.000135

216.7	0.069161	16.66	2.121212	0.000137
216.8	0.069337	16.856	2.146168	0.000138
216.9	0.069478	17.052	2.171123	0.00014
217	0.069612	17.248	2.196079	0.000141
217.1	0.069821	17.444	2.221034	0.000143
217.2	0.069956	17.64	2.245989	0.000144
217.3	0.070079	17.836	2.270945	0.000146
217.4	0.070212	18.032	2.2959	0.000147
217.5	0.070391	18.228	2.320856	0.000149
217.6	0.070543	18.424	2.345811	0.00015
217.7	0.070662	18.62	2.370767	0.000152
217.8	0.070738	18.816	2.395722	0.000152
217.9	0.070925	19.012	2.420677	0.000154
218	0.071179	19.208	2.445633	0.000157
218.1	0.071291	19.404	2.470588	0.000158
218.2	0.071409	19.6	2.495544	0.000159
218.3	0.071575	19.796	2.520499	0.000161
218.4	0.071787	19.992	2.545455	0.000163
218.5	0.071963	20.188	2.57041	0.000165
218.6	0.072037	20.384	2.595366	0.000165
218.7	0.072157	20.58	2.620321	0.000166
218.8	0.072379	20.776	2.645276	0.000169
218.9	0.072518	20.972	2.670232	0.00017
219	0.072566	21.168	2.695187	0.000171
219.1	0.072735	21.364	2.720143	0.000172
219.2	0.072932	21.56	2.745098	0.000174
219.3	0.072996	21.756	2.770054	0.000175
219.4	0.073113	21.952	2.795009	0.000176
219.5	0.073325	22.148	2.819964	0.000178
219.6	0.073455	22.344	2.84492	0.000179
219.7	0.073628	22.54	2.869875	0.000181
219.8	0.073717	22.736	2.894831	0.000182
219.9	0.073818	22.932	2.919786	0.000183
220	0.07396	23.128	2.944742	0.000185
220.1	0.07415	23.324	2.969697	0.000186
220.2	0.07433	23.52	2.994653	0.000188
220.3	0.074407	23.716	3.019608	0.000189
220.4	0.074497	23.912	3.044563	0.00019
220.5	0.074689	24.108	3.069519	0.000192
220.6	0.074827	24.304	3.094474	0.000193
220.7	0.07501	24.5	3.11943	0.000195
220.8	0.075114	24.696	3.144385	0.000196
220.9	0.075264	24.892	3.169341	0.000198
221	0.075376	25.088	3.194296	0.000199
221.1	0.075518	25.284	3.219251	0.0002
221.2	0.07573	25.48	3.244207	0.000202
221.3	0.075843	25.676	3.269162	0.000203
221.4	0.075951	25.872	3.294118	0.000204
221.5	0.076102	26.068	3.319073	0.000206
221.6	0.076211	26.264	3.344029	0.000207
221.7	0.076361	26.46	3.368984	0.000209
221.8	0.076545	26.656	3.39394	0.00021
221.9	0.076657	26.852	3.418895	0.000211
222	0.076791	27.048	3.44385	0.000213
222.1	0.07694	27.244	3.468806	0.000214

222.2	0.077114	27.44	3.493761	0.000216
222.3	0.077252	27.636	3.518717	0.000217
222.4	0.077398	27.832	3.543672	0.000219
222.5	0.077521	28.028	3.568628	0.00022
222.6	0.077639	28.224	3.593583	0.000221
222.7	0.07779	28.42	3.618538	0.000223
222.8	0.077937	28.616	3.643494	0.000224
222.9	0.078084	28.812	3.668449	0.000226
223	0.078239	29.008	3.693405	0.000227
223.1	0.078376	29.204	3.71836	0.000229
223.2	0.078491	29.4	3.743316	0.00023
223.3	0.078604	29.596	3.768271	0.000231
223.4	0.078695	29.792	3.793227	0.000232
223.5	0.078841	29.988	3.818182	0.000233
223.6	0.07899	30.184	3.843137	0.000235
223.7	0.079113	30.38	3.868093	0.000236
223.8	0.079254	30.576	3.893048	0.000237
223.9	0.079392	30.772	3.918004	0.000239
224	0.079516	30.968	3.942959	0.00024
224.1	0.079651	31.164	3.967915	0.000241
224.2	0.079787	31.36	3.99287	0.000243
224.3	0.079948	31.556	4.017826	0.000244
224.4	0.080072	31.752	4.042781	0.000246
224.5	0.080172	31.948	4.067736	0.000247
224.6	0.080349	32.144	4.092692	0.000248
224.7	0.080454	32.34	4.117647	0.000249
224.8	0.080546	32.536	4.142603	0.00025
224.9	0.080705	32.732	4.167558	0.000252
225	0.080859	32.928	4.192514	0.000254
225.1	0.080969	33.124	4.217469	0.000255
225.2	0.081065	33.32	4.242424	0.000256
225.3	0.081256	33.516	4.26738	0.000257
225.4	0.081411	33.712	4.292335	0.000259
225.5	0.08151	33.908	4.317291	0.00026
225.6	0.081621	34.104	4.342246	0.000261
225.7	0.081791	34.3	4.367202	0.000263
225.8	0.081895	34.496	4.392157	0.000264
225.9	0.081988	34.692	4.417113	0.000265
226	0.082124	34.888	4.442068	0.000266
226.1	0.082279	35.084	4.467023	0.000268
226.2	0.082398	35.28	4.491979	0.000269
226.3	0.0825	35.476	4.516934	0.00027
226.4	0.082627	35.672	4.54189	0.000271
226.5	0.082789	35.868	4.566845	0.000273
226.6	0.082921	36.064	4.591801	0.000274
226.7	0.083046	36.26	4.616756	0.000275
226.8	0.083169	36.456	4.641711	0.000277
226.9	0.083278	36.652	4.666667	0.000278
227	0.083426	36.848	4.691622	0.000279
227.1	0.083564	37.044	4.716578	0.000281
227.2	0.083746	37.24	4.741533	0.000282
227.3	0.083876	37.436	4.766489	0.000284
227.4	0.083969	37.632	4.791444	0.000285
227.5	0.084101	37.828	4.8164	0.000286
227.6	0.084243	38.024	4.841355	0.000287

227.7	0.084316	38.22	4.86631	0.000288
227.8	0.084474	38.416	4.891266	0.00029
227.9	0.084614	38.612	4.916221	0.000291
228	0.084749	38.808	4.941177	0.000292
228.1	0.084854	39.004	4.966132	0.000293
228.2	0.084962	39.2	4.991088	0.000295
228.3	0.085139	39.396	5.016043	0.000296
228.4	0.085256	39.592	5.040998	0.000297
228.5	0.085391	39.788	5.065954	0.000299
228.6	0.085523	39.984	5.090909	0.0003
228.7	0.085656	40.18	5.115865	0.000301
228.8	0.085751	40.376	5.14082	0.000302
228.9	0.085878	40.572	5.165776	0.000304
229	0.085987	40.768	5.190731	0.000305
229.1	0.086112	40.964	5.215687	0.000306
229.2	0.086233	41.16	5.240642	0.000307
229.3	0.086405	41.356	5.265597	0.000309
229.4	0.086511	41.552	5.290553	0.00031
229.5	0.086589	41.748	5.315508	0.000311
229.6	0.086729	41.944	5.340464	0.000312
229.7	0.086848	42.14	5.365419	0.000313
229.8	0.087008	42.336	5.390375	0.000315
229.9	0.087114	42.532	5.41533	0.000316
230	0.087225	42.728	5.440285	0.000317
230.1	0.087362	42.924	5.465241	0.000319
230.2	0.087476	43.12	5.490196	0.00032
230.3	0.08761	43.316	5.515152	0.000321
230.4	0.087735	43.512	5.540107	0.000322
230.5	0.087827	43.708	5.565063	0.000323
230.6	0.087993	43.904	5.590018	0.000325
230.7	0.088095	44.1	5.614974	0.000326
230.8	0.088172	44.296	5.639929	0.000327
230.9	0.088336	44.492	5.664884	0.000328
231	0.08847	44.688	5.68984	0.00033
231.1	0.088608	44.884	5.714795	0.000331
231.2	0.088691	45.08	5.739751	0.000332
231.3	0.088848	45.276	5.764706	0.000333
231.4	0.088906	45.472	5.789662	0.000334
231.5	0.089078	45.668	5.814617	0.000336
231.6	0.089241	45.864	5.839572	0.000337
231.7	0.089354	46.06	5.864528	0.000338
231.8	0.089398	46.256	5.889483	0.000339
231.9	0.089516	46.452	5.914439	0.00034
232	0.089732	46.648	5.939394	0.000342
232.1	0.089852	46.844	5.96435	0.000343
232.2	0.089949	47.04	5.989305	0.000344
232.3	0.090065	47.236	6.014261	0.000346
232.4	0.090164	47.432	6.039216	0.000347
232.5	0.09037	47.628	6.064171	0.000349
232.6	0.09044	47.824	6.089127	0.000349
232.7	0.090544	48.02	6.114082	0.00035
232.8	0.090734	48.216	6.139038	0.000352
232.9	0.090756	48.412	6.163993	0.000352
233	0.090904	48.608	6.188949	0.000354
233.1	0.091069	48.804	6.213904	0.000356

233.2	0.091117	49	6.238859	0.000356
233.3	0.091286	49.196	6.263815	0.000358
233.4	0.09148	49.392	6.28877	0.00036
233.5	0.09147	49.588	6.313726	0.00036
233.6	0.091592	49.784	6.338681	0.000361
233.7	0.091739	49.98	6.363637	0.000362
233.8	0.091933	50.176	6.388592	0.000364
233.9	0.091955	50.372	6.413548	0.000364
234	0.092006	50.568	6.438503	0.000365
234.1	0.092163	50.764	6.463458	0.000367
234.2	0.092418	50.96	6.488414	0.000369
234.3	0.092498	51.156	6.513369	0.00037
234.4	0.092633	51.352	6.538325	0.000371
234.5	0.092786	51.548	6.56328	0.000373
234.6	0.092812	51.744	6.588236	0.000373
234.7	0.092926	51.94	6.613191	0.000374
234.8	0.092957	52.136	6.638146	0.000374
234.9	0.093171	52.332	6.663102	0.000377
235	0.09342	52.528	6.688057	0.000379
235.1	0.093392	52.724	6.713013	0.000379
235.2	0.09348	52.92	6.737968	0.00038
235.3	0.093665	53.116	6.762924	0.000382
235.4	0.093901	53.312	6.787879	0.000384
235.5	0.093939	53.508	6.812835	0.000384
235.6	0.093982	53.704	6.83779	0.000385
235.7	0.094126	53.9	6.862745	0.000386
235.8	0.094256	54.096	6.887701	0.000387
235.9	0.094389	54.292	6.912656	0.000389
236	0.09449	54.488	6.937612	0.00039
236.1	0.094476	54.684	6.962567	0.00039
236.2	0.094663	54.88	6.987523	0.000392
236.3	0.09483	55.076	7.012478	0.000393
236.4	0.09493	55.272	7.037433	0.000394
236.5	0.095036	55.468	7.062389	0.000395
236.6	0.095139	55.664	7.087344	0.000396
236.7	0.095256	55.86	7.1123	0.000397
236.8	0.095371	56.056	7.137255	0.000399
236.9	0.095468	56.252	7.162211	0.0004
237	0.095506	56.448	7.187166	0.0004
237.1	0.095695	56.644	7.212122	0.000402
237.2	0.095854	56.84	7.237077	0.000403
237.3	0.095944	57.036	7.262032	0.000404
237.4	0.095978	57.232	7.286988	0.000405
237.5	0.096111	57.428	7.311943	0.000406
237.6	0.0963	57.624	7.336899	0.000408
237.7	0.096402	57.82	7.361854	0.000409
237.8	0.096461	58.016	7.38681	0.00041
237.9	0.09659	58.212	7.411765	0.000411
238	0.096744	58.408	7.43672	0.000412
238.1	0.09685	58.604	7.461676	0.000413
238.2	0.097061	58.8	7.486631	0.000416
238.3	0.097207	58.996	7.511587	0.000417
238.4	0.097304	59.192	7.536542	0.000418
238.5	0.097297	59.388	7.561498	0.000418
238.6	0.097341	59.584	7.586453	0.000418

238.7	0.097577	59.78	7.611409	0.000421
238.8	0.097759	59.976	7.636364	0.000423
238.9	0.097911	60.172	7.661319	0.000424
239	0.097874	60.368	7.686275	0.000424
239.1	0.097909	60.564	7.71123	0.000424
239.2	0.098112	60.76	7.736186	0.000426
239.3	0.098347	60.956	7.761141	0.000428
239.4	0.098458	61.152	7.786097	0.00043
239.5	0.098396	61.348	7.811052	0.000429
239.6	0.098498	61.544	7.836008	0.00043
239.7	0.098715	61.74	7.860963	0.000432
239.8	0.098911	61.936	7.885918	0.000434
239.9	0.0989	62.132	7.910874	0.000434
240	0.098975	62.328	7.935829	0.000435
240.1	0.099157	62.524	7.960785	0.000436
240.2	0.099307	62.72	7.98574	0.000438
240.3	0.099401	62.916	8.010696	0.000439
240.4	0.099411	63.112	8.035651	0.000439
240.5	0.099531	63.308	8.060606	0.00044
240.6	0.099702	63.504	8.085562	0.000442
240.7	0.099853	63.7	8.110517	0.000443
240.8	0.1	63.896	8.135473	0.000445
240.9	0.100115	64.092	8.160428	0.000446
241	0.10014	64.288	8.185384	0.000446
241.1	0.100286	64.484	8.210339	0.000448
241.2	0.100408	64.68	8.235295	0.000449
241.3	0.100414	64.876	8.26025	0.000449
241.4	0.100569	65.072	8.285205	0.000451
241.5	0.100714	65.268	8.310161	0.000452
241.6	0.100872	65.464	8.335116	0.000454
241.7	0.100912	65.66	8.360072	0.000454
241.8	0.101019	65.856	8.385027	0.000455
241.9	0.101224	66.052	8.409983	0.000457
242	0.101414	66.248	8.434938	0.000459
242.1	0.101541	66.444	8.459893	0.00046
242.2	0.101506	66.64	8.484849	0.00046
242.3	0.101614	66.836	8.509804	0.000461
242.4	0.101793	67.032	8.53476	0.000463
242.5	0.101946	67.228	8.559715	0.000464
242.6	0.102029	67.424	8.584671	0.000465
242.7	0.102077	67.62	8.609626	0.000466

B.1.13 Elastic Modulus test results of SFRGC(K) at 400°C temperature.

Time	Absolute	Force	Stress	Strain
122.6	0.131987	0	0	0
122.7	0.132153	0.196	0.024955	1.66E-06
122.8	0.13229	0.392	0.049911	3.03E-06
122.9	0.132441	0.588	0.074866	4.54E-06
123	0.132603	0.784	0.099822	6.16E-06
123.1	0.13282	0.98	0.124777	8.33E-06
123.2	0.132985	1.176	0.149733	9.98E-06

123.3	0.133109	1.372	0.174688	1.12E-05
123.4	0.133263	1.568	0.199644	1.28E-05
123.5	0.133475	1.764	0.224599	1.49E-05
123.6	0.133636	1.96	0.249554	1.65E-05
123.7	0.133854	2.156	0.27451	1.87E-05
123.8	0.134062	2.352	0.299465	2.07E-05
123.9	0.134194	2.548	0.324421	2.21E-05
124	0.134403	2.744	0.349376	2.42E-05
124.1	0.134595	2.94	0.374332	2.61E-05
124.2	0.134769	3.136	0.399287	2.78E-05
124.3	0.134987	3.332	0.424242	3E-05
124.4	0.135203	3.528	0.449198	3.22E-05
124.5	0.135395	3.724	0.474153	3.41E-05
124.6	0.135581	3.92	0.499109	3.59E-05
124.7	0.135764	4.116	0.524064	3.78E-05
124.8	0.135913	4.312	0.54902	3.93E-05
124.9	0.136087	4.508	0.573975	4.1E-05
125	0.136289	4.704	0.598931	4.3E-05
125.1	0.136529	4.9	0.623886	4.54E-05
125.2	0.136706	5.096	0.648841	4.72E-05
125.3	0.136852	5.292	0.673797	4.86E-05
125.4	0.137086	5.488	0.698752	5.1E-05
125.5	0.137295	5.684	0.723708	5.31E-05
125.6	0.137448	5.88	0.748663	5.46E-05
125.7	0.137641	6.076	0.773619	5.65E-05
125.8	0.137816	6.272	0.798574	5.83E-05
125.9	0.13803	6.468	0.823529	6.04E-05
126	0.13823	6.664	0.848485	6.24E-05
126.1	0.138417	6.86	0.87344	6.43E-05
126.2	0.138639	7.056	0.898396	6.65E-05
126.3	0.138861	7.252	0.923351	6.87E-05
126.4	0.139045	7.448	0.948307	7.06E-05
126.5	0.139232	7.644	0.973262	7.25E-05
126.6	0.139382	7.84	0.998218	7.39E-05
126.7	0.139577	8.036	1.023173	7.59E-05
126.8	0.139839	8.232	1.048128	7.85E-05
126.9	0.140072	8.428	1.073084	8.08E-05
127	0.140234	8.624	1.098039	8.25E-05
127.1	0.140483	8.82	1.122995	8.5E-05
127.2	0.140692	9.016	1.14795	8.71E-05
127.3	0.140904	9.212	1.172906	8.92E-05
127.4	0.141162	9.408	1.197861	9.17E-05
127.5	0.141349	9.604	1.222816	9.36E-05
127.6	0.141528	9.8	1.247772	9.54E-05
127.7	0.141732	9.996	1.272727	9.74E-05
127.8	0.14195	10.192	1.297683	9.96E-05
127.9	0.142174	10.388	1.322638	0.000102
128	0.142361	10.584	1.347594	0.000104
128.1	0.142541	10.78	1.372549	0.000106
128.2	0.142743	10.976	1.397505	0.000108
128.3	0.142939	11.172	1.42246	0.00011
128.4	0.143139	11.368	1.447415	0.000112
128.5	0.143343	11.564	1.472371	0.000114
128.6	0.143553	11.76	1.497326	0.000116
128.7	0.143736	11.956	1.522282	0.000117

128.8	0.14391	12.152	1.547237	0.000119
128.9	0.144095	12.348	1.572193	0.000121
129	0.144345	12.544	1.597148	0.000124
129.1	0.144566	12.74	1.622103	0.000126
129.2	0.14479	12.936	1.647059	0.000128
129.3	0.144969	13.132	1.672014	0.00013
129.4	0.145147	13.328	1.69697	0.000132
129.5	0.145358	13.524	1.721925	0.000134
129.6	0.145546	13.72	1.746881	0.000136
129.7	0.145742	13.916	1.771836	0.000138
129.8	0.145965	14.112	1.796792	0.00014
129.9	0.146167	14.308	1.821747	0.000142
130	0.146335	14.504	1.846702	0.000143
130.1	0.146546	14.7	1.871658	0.000146
130.2	0.14678	14.896	1.896613	0.000148
130.3	0.14697	15.092	1.921569	0.00015
130.4	0.147156	15.288	1.946524	0.000152
130.5	0.147342	15.484	1.97148	0.000154
130.6	0.147577	15.68	1.996435	0.000156
130.7	0.147766	15.876	2.02139	0.000158
130.8	0.147942	16.072	2.046346	0.00016
130.9	0.148171	16.268	2.071301	0.000162
131	0.148376	16.464	2.096257	0.000164
131.1	0.148565	16.66	2.121212	0.000166
131.2	0.148786	16.856	2.146168	0.000168
131.3	0.148948	17.052	2.171123	0.00017
131.4	0.149134	17.248	2.196079	0.000171
131.5	0.149395	17.444	2.221034	0.000174
131.6	0.149597	17.64	2.245989	0.000176
131.7	0.149737	17.836	2.270945	0.000178
131.8	0.150019	18.032	2.2959	0.00018
131.9	0.150234	18.228	2.320856	0.000182
132	0.150349	18.424	2.345811	0.000184
132.1	0.150554	18.62	2.370767	0.000186
132.2	0.150755	18.816	2.395722	0.000188
132.3	0.15094	19.012	2.420677	0.00019
132.4	0.151082	19.208	2.445633	0.000191
132.5	0.151262	19.404	2.470588	0.000193
132.6	0.151526	19.6	2.495544	0.000195
132.7	0.151733	19.796	2.520499	0.000197
132.8	0.151924	19.992	2.545455	0.000199
132.9	0.152102	20.188	2.57041	0.000201
133	0.152258	20.384	2.595366	0.000203
133.1	0.152461	20.58	2.620321	0.000205
133.2	0.152672	20.776	2.645276	0.000207
133.3	0.152881	20.972	2.670232	0.000209
133.4	0.15303	21.168	2.695187	0.00021
133.5	0.15323	21.364	2.720143	0.000212
133.6	0.153412	21.56	2.745098	0.000214
133.7	0.153606	21.756	2.770054	0.000216
133.8	0.15381	21.952	2.795009	0.000218
133.9	0.154034	22.148	2.819964	0.00022
134	0.154243	22.344	2.84492	0.000223
134.1	0.154337	22.54	2.869875	0.000223
134.2	0.154517	22.736	2.894831	0.000225

134.3	0.15471	22.932	2.919786	0.000227
134.4	0.154889	23.128	2.944742	0.000229
134.5	0.155104	23.324	2.969697	0.000231
134.6	0.155337	23.52	2.994653	0.000233
134.7	0.15548	23.716	3.019608	0.000235
134.8	0.155601	23.912	3.044563	0.000236
134.9	0.155818	24.108	3.069519	0.000238
135	0.156071	24.304	3.094474	0.000241
135.1	0.15622	24.5	3.11943	0.000242
135.2	0.156378	24.696	3.144385	0.000244
135.3	0.156577	24.892	3.169341	0.000246
135.4	0.156787	25.088	3.194296	0.000248
135.5	0.156934	25.284	3.219251	0.000249
135.6	0.157142	25.48	3.244207	0.000252
135.7	0.157307	25.676	3.269162	0.000253
135.8	0.157514	25.872	3.294118	0.000255
135.9	0.157668	26.068	3.319073	0.000257
136	0.157847	26.264	3.344029	0.000259
136.1	0.158028	26.46	3.368984	0.00026
136.2	0.158245	26.656	3.39394	0.000263
136.3	0.158434	26.852	3.418895	0.000264
136.4	0.158622	27.048	3.44385	0.000266
136.5	0.158833	27.244	3.468806	0.000268
136.6	0.159004	27.44	3.493761	0.00027
136.7	0.159174	27.636	3.518717	0.000272
136.8	0.159376	27.832	3.543672	0.000274
136.9	0.159566	28.028	3.568628	0.000276
137	0.159733	28.224	3.593583	0.000277
137.1	0.159931	28.42	3.618538	0.000279
137.2	0.160147	28.616	3.643494	0.000282
137.3	0.1603	28.812	3.668449	0.000283
137.4	0.160448	29.008	3.693405	0.000285
137.5	0.160644	29.204	3.71836	0.000287
137.6	0.160833	29.4	3.743316	0.000288
137.7	0.161033	29.596	3.768271	0.00029
137.8	0.161175	29.792	3.793227	0.000292
137.9	0.161391	29.988	3.818182	0.000294
138	0.161516	30.184	3.843137	0.000295
138.1	0.161688	30.38	3.868093	0.000297
138.2	0.161871	30.576	3.893048	0.000299
138.3	0.162067	30.772	3.918004	0.000301
138.4	0.162269	30.968	3.942959	0.000303
138.5	0.162417	31.164	3.967915	0.000304
138.6	0.162587	31.36	3.99287	0.000306
138.7	0.162787	31.556	4.017826	0.000308
138.8	0.162973	31.752	4.042781	0.00031
138.9	0.163112	31.948	4.067736	0.000311
139	0.16331	32.144	4.092692	0.000313
139.1	0.163495	32.34	4.117647	0.000315
139.2	0.163648	32.536	4.142603	0.000317
139.3	0.163851	32.732	4.167558	0.000319
139.4	0.164024	32.928	4.192514	0.00032
139.5	0.164187	33.124	4.217469	0.000322
139.6	0.164379	33.32	4.242424	0.000324
139.7	0.164575	33.516	4.26738	0.000326

139.8	0.164765	33.712	4.292335	0.000328
139.9	0.164893	33.908	4.317291	0.000329
140	0.165071	34.104	4.342246	0.000331
140.1	0.165272	34.3	4.367202	0.000333
140.2	0.165454	34.496	4.392157	0.000335
140.3	0.165633	34.692	4.417113	0.000336
140.4	0.165762	34.888	4.442068	0.000338
140.5	0.165944	35.084	4.467023	0.00034
140.6	0.16611	35.28	4.491979	0.000341
140.7	0.166275	35.476	4.516934	0.000343
140.8	0.166443	35.672	4.54189	0.000345
140.9	0.166604	35.868	4.566845	0.000346
141	0.166815	36.064	4.591801	0.000348
141.1	0.166976	36.26	4.616756	0.00035
141.2	0.167134	36.456	4.641711	0.000351
141.3	0.167302	36.652	4.666667	0.000353
141.4	0.16754	36.848	4.691622	0.000356
141.5	0.167707	37.044	4.716578	0.000357
141.6	0.167872	37.24	4.741533	0.000359
141.7	0.168068	37.436	4.766489	0.000361
141.8	0.168231	37.632	4.791444	0.000362
141.9	0.16835	37.828	4.8164	0.000364
142	0.168566	38.024	4.841355	0.000366
142.1	0.16875	38.22	4.86631	0.000368
142.2	0.168908	38.416	4.891266	0.000369
142.3	0.169075	38.612	4.916221	0.000371
142.4	0.169275	38.808	4.941177	0.000373
142.5	0.169451	39.004	4.966132	0.000375
142.6	0.169613	39.2	4.991088	0.000376
142.7	0.169784	39.396	5.016043	0.000378
142.8	0.169946	39.592	5.040998	0.00038
142.9	0.170127	39.788	5.065954	0.000381
143	0.170301	39.984	5.090909	0.000383
143.1	0.170461	40.18	5.115865	0.000385
143.2	0.170568	40.376	5.14082	0.000386
143.3	0.17075	40.572	5.165776	0.000388
143.4	0.17091	40.768	5.190731	0.000389
143.5	0.171075	40.964	5.215687	0.000391
143.6	0.1712	41.16	5.240642	0.000392
143.7	0.171333	41.356	5.265597	0.000393
143.8	0.171481	41.552	5.290553	0.000395
143.9	0.171724	41.748	5.315508	0.000397
144	0.171876	41.944	5.340464	0.000399
144.1	0.172011	42.14	5.365419	0.0004
144.2	0.172228	42.336	5.390375	0.000402
144.3	0.172369	42.532	5.41533	0.000404
144.4	0.172558	42.728	5.440285	0.000406
144.5	0.172756	42.924	5.465241	0.000408
144.6	0.172841	43.12	5.490196	0.000409
144.7	0.173057	43.316	5.515152	0.000411
144.8	0.173263	43.512	5.540107	0.000413
144.9	0.173382	43.708	5.565063	0.000414
145	0.173517	43.904	5.590018	0.000415
145.1	0.173717	44.1	5.614974	0.000417
145.2	0.173879	44.296	5.639929	0.000419

145.3	0.174064	44.492	5.664884	0.000421
145.4	0.174201	44.688	5.68984	0.000422
145.5	0.174324	44.884	5.714795	0.000423
145.6	0.174572	45.08	5.739751	0.000426
145.7	0.174679	45.276	5.764706	0.000427
145.8	0.174909	45.472	5.789662	0.000429
145.9	0.175049	45.668	5.814617	0.000431
146	0.175198	45.864	5.839572	0.000432
146.1	0.175343	46.06	5.864528	0.000434
146.2	0.175613	46.256	5.889483	0.000436
146.3	0.175696	46.452	5.914439	0.000437
146.4	0.175867	46.648	5.939394	0.000439
146.5	0.175981	46.844	5.96435	0.00044
146.6	0.176218	47.04	5.989305	0.000442
146.7	0.176313	47.236	6.014261	0.000443
146.8	0.176523	47.432	6.039216	0.000445
146.9	0.176634	47.628	6.064171	0.000446
147	0.176828	47.824	6.089127	0.000448
147.1	0.176962	48.02	6.114082	0.00045
147.2	0.177065	48.216	6.139038	0.000451
147.3	0.177279	48.412	6.163993	0.000453
147.4	0.177467	48.608	6.188949	0.000455
147.5	0.177548	48.804	6.213904	0.000456
147.6	0.177679	49	6.238859	0.000457
147.7	0.177799	49.196	6.263815	0.000458
147.8	0.177907	49.392	6.28877	0.000459
147.9	0.178118	49.588	6.313726	0.000461
148	0.178448	49.784	6.338681	0.000465
148.1	0.17855	49.98	6.363637	0.000466
148.2	0.178703	50.176	6.388592	0.000467
148.3	0.17892	50.372	6.413548	0.000469
148.4	0.178974	50.568	6.438503	0.00047
148.5	0.179039	50.764	6.463458	0.000471
148.6	0.179324	50.96	6.488414	0.000473
148.7	0.179573	51.156	6.513369	0.000476
148.8	0.179584	51.352	6.538325	0.000476
148.9	0.179692	51.548	6.56328	0.000477
149	0.179994	51.744	6.588236	0.00048
149.1	0.18021	51.94	6.613191	0.000482
149.2	0.18022	52.136	6.638146	0.000482
149.3	0.180435	52.332	6.663102	0.000484
149.4	0.180755	52.528	6.688057	0.000488
149.5	0.1808	52.724	6.713013	0.000488
149.6	0.180839	52.92	6.737968	0.000489
149.7	0.181153	53.116	6.762924	0.000492
149.8	0.181349	53.312	6.787879	0.000494
149.9	0.181444	53.508	6.812835	0.000495
150	0.181473	53.704	6.83779	0.000495
150.1	0.181753	53.9	6.862745	0.000498
150.2	0.181932	54.096	6.887701	0.000499
150.3	0.182069	54.292	6.912656	0.000501
150.4	0.182134	54.488	6.937612	0.000501
150.5	0.182407	54.684	6.962567	0.000504
150.6	0.182594	54.88	6.987523	0.000506
150.7	0.182529	55.076	7.012478	0.000505

150.8	0.182749	55.272	7.037433	0.000508
150.9	0.182909	55.468	7.062389	0.000509
151	0.182993	55.664	7.087344	0.00051
151.1	0.183236	55.86	7.1123	0.000512
151.2	0.183337	56.056	7.137255	0.000513
151.3	0.183463	56.252	7.162211	0.000515
151.4	0.183725	56.448	7.187166	0.000517
151.5	0.183802	56.644	7.212122	0.000518
151.6	0.183891	56.84	7.237077	0.000519
151.7	0.184142	57.036	7.262032	0.000522
151.8	0.184243	57.232	7.286988	0.000523
151.9	0.184425	57.428	7.311943	0.000524
152	0.184565	57.624	7.336899	0.000526
152.1	0.184727	57.82	7.361854	0.000527
152.2	0.184889	58.016	7.38681	0.000529
152.3	0.184992	58.212	7.411765	0.00053
152.4	0.185212	58.408	7.43672	0.000532
152.5	0.18542	58.604	7.461676	0.000534
152.6	0.185664	58.8	7.486631	0.000537
152.7	0.185872	58.996	7.511587	0.000539
152.8	0.185884	59.192	7.536542	0.000539
152.9	0.185972	59.388	7.561498	0.00054
153	0.186199	59.584	7.586453	0.000542
153.1	0.186451	59.78	7.611409	0.000545
153.2	0.186568	59.976	7.636364	0.000546
153.3	0.186555	60.172	7.661319	0.000546
153.4	0.186757	60.368	7.686275	0.000548
153.5	0.186979	60.564	7.71123	0.00055
153.6	0.187186	60.76	7.736186	0.000552
153.7	0.187375	60.956	7.761141	0.000554
153.8	0.187426	61.152	7.786097	0.000554
153.9	0.187505	61.348	7.811052	0.000555
154	0.18768	61.544	7.836008	0.000557
154.1	0.187793	61.74	7.860963	0.000558
154.2	0.187978	61.936	7.885918	0.00056
154.3	0.188112	62.132	7.910874	0.000561
154.4	0.188232	62.328	7.935829	0.000562
154.5	0.188369	62.524	7.960785	0.000564
154.6	0.18852	62.72	7.98574	0.000565
154.7	0.188712	62.916	8.010696	0.000567
154.8	0.188841	63.112	8.035651	0.000569
154.9	0.188996	63.308	8.060606	0.00057
155	0.189122	63.504	8.085562	0.000571
155.1	0.189291	63.7	8.110517	0.000573
155.2	0.189391	63.896	8.135473	0.000574
155.3	0.189556	64.092	8.160428	0.000576
155.4	0.189754	64.288	8.185384	0.000578
155.5	0.189861	64.484	8.210339	0.000579
155.6	0.190022	64.68	8.235295	0.00058
155.7	0.190189	64.876	8.26025	0.000582
155.8	0.190364	65.072	8.285205	0.000584
155.9	0.19045	65.268	8.310161	0.000585
156	0.19065	65.464	8.335116	0.000587
156.1	0.190843	65.66	8.360072	0.000589
156.2	0.190915	65.856	8.385027	0.000589

156.3	0.191039	66.052	8.409983	0.000591
156.4	0.191267	66.248	8.434938	0.000593
156.5	0.191478	66.444	8.459893	0.000595
156.6	0.191503	66.64	8.484849	0.000595
156.7	0.191647	66.836	8.509804	0.000597
156.8	0.191805	67.032	8.53476	0.000598
156.9	0.19197	67.228	8.559715	0.0006
157	0.19217	67.424	8.584671	0.000602
157.1	0.192251	67.62	8.609626	0.000603
157.2	0.192408	67.816	8.634582	0.000604
157.3	0.192607	68.012	8.659537	0.000606
157.4	0.192721	68.208	8.684492	0.000607
157.5	0.192824	68.404	8.709448	0.000608
157.6	0.193027	68.6	8.734403	0.00061
157.7	0.193208	68.796	8.759359	0.000612
157.8	0.193285	68.992	8.784314	0.000613
157.9	0.193463	69.188	8.80927	0.000615
158	0.193617	69.384	8.834225	0.000616
158.1	0.193704	69.58	8.85918	0.000617
158.2	0.193838	69.776	8.884136	0.000619
158.3	0.193978	69.972	8.909091	0.00062
158.4	0.194128	70.168	8.934047	0.000621
158.5	0.194252	70.364	8.959002	0.000623
158.6	0.19441	70.56	8.983958	0.000624
158.7	0.194604	70.756	9.008913	0.000626
158.8	0.194666	70.952	9.033869	0.000627
158.9	0.194853	71.148	9.058824	0.000629
159	0.195069	71.344	9.083779	0.000631
159.1	0.19511	71.54	9.108735	0.000631
159.2	0.195318	71.736	9.13369	0.000633
159.3	0.195524	71.932	9.158646	0.000635
159.4	0.195564	72.128	9.183601	0.000636
159.5	0.19576	72.324	9.208557	0.000638
159.6	0.195923	72.52	9.233512	0.000639
159.7	0.196001	72.716	9.258467	0.00064
159.8	0.196241	72.912	9.283423	0.000643
159.9	0.196362	73.108	9.308378	0.000644
160	0.196503	73.304	9.333334	0.000645
160.1	0.196636	73.5	9.358289	0.000646
160.2	0.196843	73.696	9.383245	0.000649
160.3	0.196952	73.892	9.4082	0.00065
160.4	0.197066	74.088	9.433156	0.000651
160.5	0.197276	74.284	9.458111	0.000653
160.6	0.197444	74.48	9.483066	0.000655
160.7	0.197492	74.676	9.508022	0.000655
160.8	0.197703	74.872	9.532977	0.000657
160.9	0.19784	75.068	9.557933	0.000659
161	0.197922	75.264	9.582888	0.000659
161.1	0.198103	75.46	9.607844	0.000661
161.2	0.198251	75.656	9.632799	0.000663
161.3	0.198328	75.852	9.657754	0.000663
161.4	0.198564	76.048	9.68271	0.000666
161.5	0.198645	76.244	9.707665	0.000667
161.6	0.198765	76.44	9.732621	0.000668
161.7	0.198931	76.636	9.757576	0.000669

161.8	0.199065	76.832	9.782532	0.000671
161.9	0.199235	77.028	9.807487	0.000672
162	0.199372	77.224	9.832443	0.000674
162.1	0.199507	77.42	9.857398	0.000675
162.2	0.199704	77.616	9.882353	0.000677
162.3	0.199767	77.812	9.907309	0.000678
162.4	0.19992	78.008	9.932264	0.000679
162.5	0.200118	78.204	9.95722	0.000681
162.6	0.200173	78.4	9.982175	0.000682
162.7	0.200385	78.596	10.00713	0.000684
162.8	0.200519	78.792	10.03209	0.000685
162.9	0.200707	78.988	10.05704	0.000687
163	0.200856	79.184	10.082	0.000689
163.1	0.200927	79.38	10.10695	0.000689
163.2	0.201127	79.576	10.13191	0.000691
163.3	0.201256	79.772	10.15686	0.000693
163.4	0.201416	79.968	10.18182	0.000694
163.5	0.201578	80.164	10.20677	0.000696
163.6	0.201677	80.36	10.23173	0.000697
163.7	0.201888	80.556	10.25668	0.000699
163.8	0.202019	80.752	10.28164	0.0007
163.9	0.202081	80.948	10.3066	0.000701
164	0.202287	81.144	10.33155	0.000703
164.1	0.202416	81.34	10.35651	0.000704
164.2	0.202557	81.536	10.38146	0.000706
164.3	0.202742	81.732	10.40642	0.000708
164.4	0.202857	81.928	10.43137	0.000709
164.5	0.20302	82.124	10.45633	0.00071
164.6	0.203143	82.32	10.48128	0.000712
164.7	0.203265	82.516	10.50624	0.000713
164.8	0.203404	82.712	10.53119	0.000714
164.9	0.203534	82.908	10.55615	0.000715
165	0.203652	83.104	10.58111	0.000717
165.1	0.203823	83.3	10.60606	0.000718
165.2	0.203986	83.496	10.63102	0.00072
165.3	0.204132	83.692	10.65597	0.000721
165.4	0.204199	83.888	10.68093	0.000722
165.5	0.204369	84.084	10.70588	0.000724
165.6	0.20458	84.28	10.73084	0.000726
165.7	0.204674	84.476	10.75579	0.000727
165.8	0.204814	84.672	10.78075	0.000728
165.9	0.204957	84.868	10.8057	0.00073
166	0.205131	85.064	10.83066	0.000731
166.1	0.205277	85.26	10.85562	0.000733
166.2	0.205394	85.456	10.88057	0.000734
166.3	0.205615	85.652	10.90553	0.000736
166.4	0.205718	85.848	10.93048	0.000737
166.5	0.205886	86.044	10.95544	0.000739

B.1.14 Elastic Modulus test results of SFRGC(K) at 600℃ temperature.

Time	Absolute	Force	Stress	Strain
165.2	0.460696	0	0	0
165.3	0.461043	0.196	0.024955	3.47E-06
165.4	0.461488	0.392	0.049911	7.92E-06
165.5	0.462137	0.588	0.074866	1.44E-05
165.6	0.462995	0.784	0.099822	2.3E-05
165.7	0.464107	0.98	0.124777	3.41E-05
165.8	0.46519	1.176	0.149733	4.49E-05
165.9	0.46622	1.372	0.174688	5.52E-05
166	0.46707	1.568	0.199644	6.37E-05
166.1	0.467796	1.764	0.224599	7.1E-05
166.2	0.468579	1.96	0.249554	7.88E-05
166.3	0.469203	2.156	0.27451	8.51E-05
166.4	0.469791	2.352	0.299465	9.09E-05
166.5	0.470414	2.548	0.324421	9.72E-05
166.6	0.470927	2.744	0.349376	0.000102
166.7	0.471455	2.94	0.374332	0.000108
166.8	0.471925	3.136	0.399287	0.000112
166.9	0.472427	3.332	0.424242	0.000117
167	0.472921	3.528	0.449198	0.000122
167.1	0.473416	3.724	0.474153	0.000127
167.2	0.473929	3.92	0.499109	0.000132
167.3	0.474437	4.116	0.524064	0.000137
167.4	0.474887	4.312	0.54902	0.000142
167.5	0.47539	4.508	0.573975	0.000147
167.6	0.475854	4.704	0.598931	0.000152
167.7	0.476337	4.9	0.623886	0.000156
167.8	0.476807	5.096	0.648841	0.000161
167.9	0.47723	5.292	0.673797	0.000165
168	0.477696	5.488	0.698752	0.00017
168.1	0.478185	5.684	0.723708	0.000175
168.2	0.478649	5.88	0.748663	0.00018
168.3	0.479103	6.076	0.773619	0.000184
168.4	0.479531	6.272	0.798574	0.000188
168.5	0.480004	6.468	0.823529	0.000193
168.6	0.480545	6.664	0.848485	0.000198
168.7	0.480944	6.86	0.87344	0.000202
168.8	0.481466	7.056	0.898396	0.000208
168.9	0.481924	7.252	0.923351	0.000212
169	0.482398	7.448	0.948307	0.000217
169.1	0.482932	7.644	0.973262	0.000222
169.2	0.483367	7.84	0.998218	0.000227
169.3	0.483866	8.036	1.023173	0.000232
169.4	0.484455	8.232	1.048128	0.000238
169.5	0.484938	8.428	1.073084	0.000242
169.6	0.48535	8.624	1.098039	0.000247
169.7	0.48576	8.82	1.122995	0.000251
169.8	0.486283	9.016	1.14795	0.000256
169.9	0.486759	9.212	1.172906	0.000261
170	0.487191	9.408	1.197861	0.000265
170.1	0.487665	9.604	1.222816	0.00027

170.2	0.488115	9.8	1.247772	0.000274
170.3	0.488516	9.996	1.272727	0.000278
170.4	0.489026	10.192	1.297683	0.000283
170.5	0.489493	10.388	1.322638	0.000288
170.6	0.489954	10.584	1.347594	0.000293
170.7	0.490328	10.78	1.372549	0.000296
170.8	0.490683	10.976	1.397505	0.0003
170.9	0.491216	11.172	1.42246	0.000305
171	0.491731	11.368	1.447415	0.00031
171.1	0.492193	11.564	1.472371	0.000315
171.2	0.492662	11.76	1.497326	0.00032
171.3	0.493099	11.956	1.522282	0.000324
171.4	0.493591	12.152	1.547237	0.000329
171.5	0.494122	12.348	1.572193	0.000334
171.6	0.49448	12.544	1.597148	0.000338
171.7	0.494852	12.74	1.622103	0.000342
171.8	0.495368	12.936	1.647059	0.000347
171.9	0.495833	13.132	1.672014	0.000351
172	0.496244	13.328	1.69697	0.000355
172.1	0.496667	13.524	1.721925	0.00036
172.2	0.497264	13.72	1.746881	0.000366
172.3	0.497711	13.916	1.771836	0.00037
172.4	0.498071	14.112	1.796792	0.000374
172.5	0.49848	14.308	1.821747	0.000378
172.6	0.498934	14.504	1.846702	0.000382
172.7	0.499484	14.7	1.871658	0.000388
172.8	0.499809	14.896	1.896613	0.000391
172.9	0.50022	15.092	1.921569	0.000395
173	0.500703	15.288	1.946524	0.0004
173.1	0.501171	15.484	1.97148	0.000405
173.2	0.501632	15.68	1.996435	0.000409
173.3	0.502025	15.876	2.02139	0.000413
173.4	0.502611	16.072	2.046346	0.000419
173.5	0.503129	16.268	2.071301	0.000424
173.6	0.503454	16.464	2.096257	0.000428
173.7	0.503866	16.66	2.121212	0.000432
173.8	0.504341	16.856	2.146168	0.000436
173.9	0.504822	17.052	2.171123	0.000441
174	0.505239	17.248	2.196079	0.000445
174.1	0.505615	17.444	2.221034	0.000449
174.2	0.506015	17.64	2.245989	0.000453
174.3	0.506376	17.836	2.270945	0.000457
174.4	0.506874	18.032	2.2959	0.000462
174.5	0.507317	18.228	2.320856	0.000466
174.6	0.507567	18.424	2.345811	0.000469
174.7	0.507969	18.62	2.370767	0.000473
174.8	0.508385	18.816	2.395722	0.000477
174.9	0.508895	19.012	2.420677	0.000482
175	0.509265	19.208	2.445633	0.000486
175.1	0.50957	19.404	2.470588	0.000489
175.2	0.510075	19.6	2.495544	0.000494
175.3	0.510505	19.796	2.520499	0.000498
175.4	0.510814	19.992	2.545455	0.000501
175.5	0.511266	20.188	2.57041	0.000506
175.6	0.511706	20.384	2.595366	0.00051

175.7	0.5121	20.58	2.620321	0.000514
175.8	0.512473	20.776	2.645276	0.000518
175.9	0.512811	20.972	2.670232	0.000521
176	0.513343	21.168	2.695187	0.000526
176.1	0.513688	21.364	2.720143	0.00053
176.2	0.514084	21.56	2.745098	0.000534
176.3	0.514448	21.756	2.770054	0.000538
176.4	0.514808	21.952	2.795009	0.000541
176.5	0.515164	22.148	2.819964	0.000545
176.6	0.515573	22.344	2.84492	0.000549
176.7	0.515936	22.54	2.869875	0.000552
176.8	0.516347	22.736	2.894831	0.000557
176.9	0.516726	22.932	2.919786	0.00056
177	0.517022	23.128	2.944742	0.000563
177.1	0.517407	23.324	2.969697	0.000567
177.2	0.517819	23.52	2.994653	0.000571
177.3	0.518172	23.716	3.019608	0.000575
177.4	0.518515	23.912	3.044563	0.000578
177.5	0.518886	24.108	3.069519	0.000582
177.6	0.519241	24.304	3.094474	0.000585
177.7	0.519594	24.5	3.11943	0.000589
177.8	0.51994	24.696	3.144385	0.000592
177.9	0.520281	24.892	3.169341	0.000596
178	0.520637	25.088	3.194296	0.000599
178.1	0.521018	25.284	3.219251	0.000603
178.2	0.521397	25.48	3.244207	0.000607
178.3	0.52171	25.676	3.269162	0.00061
178.4	0.522023	25.872	3.294118	0.000613
178.5	0.522393	26.068	3.319073	0.000617
178.6	0.522785	26.264	3.344029	0.000621
178.7	0.523128	26.46	3.368984	0.000624
178.8	0.523439	26.656	3.39394	0.000627
178.9	0.523765	26.852	3.418895	0.000631
179	0.524158	27.048	3.44385	0.000635
179.1	0.524564	27.244	3.468806	0.000639
179.2	0.524904	27.44	3.493761	0.000642
179.3	0.525269	27.636	3.518717	0.000646
179.4	0.525605	27.832	3.543672	0.000649
179.5	0.525949	28.028	3.568628	0.000653
179.6	0.526303	28.224	3.593583	0.000656
179.7	0.526687	28.42	3.618538	0.00066
179.8	0.527043	28.616	3.643494	0.000663
179.9	0.527377	28.812	3.668449	0.000667
180	0.527732	29.008	3.693405	0.00067
180.1	0.528095	29.204	3.71836	0.000674
180.2	0.528401	29.4	3.743316	0.000677
180.3	0.528685	29.596	3.768271	0.00068
180.4	0.529062	29.792	3.793227	0.000684
180.5	0.529462	29.988	3.818182	0.000688
180.6	0.529766	30.184	3.843137	0.000691
180.7	0.530066	30.38	3.868093	0.000694
180.8	0.530368	30.576	3.893048	0.000697
180.9	0.530751	30.772	3.918004	0.000701
181	0.531098	30.968	3.942959	0.000704
181.1	0.531432	31.164	3.967915	0.000707

181.2	0.53177	31.36	3.99287	0.000711
181.3	0.53208	31.556	4.017826	0.000714
181.4	0.532406	31.752	4.042781	0.000717
181.5	0.532749	31.948	4.067736	0.000721
181.6	0.533044	32.144	4.092692	0.000723
181.7	0.533351	32.34	4.117647	0.000727
181.8	0.533673	32.536	4.142603	0.00073
181.9	0.53403	32.732	4.167558	0.000733
182	0.5344	32.928	4.192514	0.000737
182.1	0.534675	33.124	4.217469	0.00074
182.2	0.535017	33.32	4.242424	0.000743
182.3	0.535385	33.516	4.26738	0.000747
182.4	0.535653	33.712	4.292335	0.00075
182.5	0.535917	33.908	4.317291	0.000752
182.6	0.536223	34.104	4.342246	0.000755
182.7	0.536635	34.3	4.367202	0.000759
182.8	0.536948	34.496	4.392157	0.000763
182.9	0.537273	34.692	4.417113	0.000766
183	0.537547	34.888	4.442068	0.000769
183.1	0.537862	35.084	4.467023	0.000772
183.2	0.538184	35.28	4.491979	0.000775
183.3	0.538472	35.476	4.516934	0.000778
183.4	0.538838	35.672	4.54189	0.000781
183.5	0.539187	35.868	4.566845	0.000785
183.6	0.539479	36.064	4.591801	0.000788
183.7	0.539785	36.26	4.616756	0.000791
183.8	0.540124	36.456	4.641711	0.000794
183.9	0.54041	36.652	4.666667	0.000797
184	0.540721	36.848	4.691622	0.0008
184.1	0.540996	37.044	4.716578	0.000803
184.2	0.54133	37.24	4.741533	0.000806
184.3	0.541596	37.436	4.766489	0.000809
184.4	0.541976	37.632	4.791444	0.000813
184.5	0.542301	37.828	4.8164	0.000816
184.6	0.542543	38.024	4.841355	0.000818
184.7	0.542843	38.22	4.86631	0.000821
184.8	0.543124	38.416	4.891266	0.000824
184.9	0.543448	38.612	4.916221	0.000828
185	0.543756	38.808	4.941177	0.000831
185.1	0.544031	39.004	4.966132	0.000833
185.2	0.544339	39.2	4.991088	0.000836
185.3	0.544672	39.396	5.016043	0.00084
185.4	0.544989	39.592	5.040998	0.000843
185.5	0.545224	39.788	5.065954	0.000845
185.6	0.545609	39.984	5.090909	0.000849
185.7	0.545887	40.18	5.115865	0.000852
185.8	0.546087	40.376	5.14082	0.000854
185.9	0.546501	40.572	5.165776	0.000858
186	0.546835	40.768	5.190731	0.000861
186.1	0.547137	40.964	5.215687	0.000864
186.2	0.547335	41.16	5.240642	0.000866
186.3	0.547631	41.356	5.265597	0.000869
186.4	0.54796	41.552	5.290553	0.000873
186.5	0.548325	41.748	5.315508	0.000876
186.6	0.548533	41.944	5.340464	0.000878

186.7	0.548955	42.14	5.365419	0.000883
186.8	0.549117	42.336	5.390375	0.000884
186.9	0.549549	42.532	5.41533	0.000889
187	0.549767	42.728	5.440285	0.000891
187.1	0.550066	42.924	5.465241	0.000894
187.2	0.55027	43.12	5.490196	0.000896
187.3	0.550577	43.316	5.515152	0.000899
187.4	0.550897	43.512	5.540107	0.000902
187.5	0.551094	43.708	5.565063	0.000904
187.6	0.551481	43.904	5.590018	0.000908
187.7	0.551724	44.1	5.614974	0.00091
187.8	0.5519	44.296	5.639929	0.000912
187.9	0.552283	44.492	5.664884	0.000916
188	0.552675	44.688	5.68984	0.00092
188.1	0.552723	44.884	5.714795	0.00092
188.2	0.552961	45.08	5.739751	0.000923
188.3	0.553213	45.276	5.764706	0.000925
188.4	0.553344	45.472	5.789662	0.000926
188.5	0.553755	45.668	5.814617	0.000931
188.6	0.554306	45.864	5.839572	0.000936
188.7	0.554646	46.06	5.864528	0.00094
188.8	0.554809	46.256	5.889483	0.000941
188.9	0.555128	46.452	5.914439	0.000944
189	0.555426	46.648	5.939394	0.000947
189.1	0.5557	46.844	5.96435	0.00095
189.2	0.555709	47.04	5.989305	0.00095
189.3	0.556011	47.236	6.014261	0.000953
189.4	0.556503	47.432	6.039216	0.000958
189.5	0.556826	47.628	6.064171	0.000961
189.6	0.556929	47.824	6.089127	0.000962
189.7	0.557085	48.02	6.114082	0.000964
189.8	0.557577	48.216	6.139038	0.000969
189.9	0.557885	48.412	6.163993	0.000972
190	0.558204	48.608	6.188949	0.000975
190.1	0.558495	48.804	6.213904	0.000978
190.2	0.55866	49	6.238859	0.00098
190.3	0.558699	49.196	6.263815	0.00098
190.4	0.559119	49.392	6.28877	0.000984
190.5	0.559339	49.588	6.313726	0.000986
190.6	0.559611	49.784	6.338681	0.000989
190.7	0.560062	49.98	6.363637	0.000994
190.8	0.560449	50.176	6.388592	0.000998
190.9	0.560662	50.372	6.413548	0.001
191	0.560667	50.568	6.438503	0.001
191.1	0.561048	50.764	6.463458	0.001004
191.2	0.561259	50.96	6.488414	0.001006
191.3	0.561526	51.156	6.513369	0.001008
191.4	0.561879	51.352	6.538325	0.001012
191.5	0.562021	51.548	6.56328	0.001013
191.6	0.562362	51.744	6.588236	0.001017
191.7	0.562633	51.94	6.613191	0.001019
191.8	0.562977	52.136	6.638146	0.001023
191.9	0.56334	52.332	6.663102	0.001026
192	0.56352	52.528	6.688057	0.001028
192.1	0.563669	52.724	6.713013	0.00103

192.2	0.56396	52.92	6.737968	0.001033
192.3	0.564246	53.116	6.762924	0.001035
192.4	0.564523	53.312	6.787879	0.001038
192.5	0.564837	53.508	6.812835	0.001041
192.6	0.565192	53.704	6.83779	0.001045
192.7	0.565436	53.9	6.862745	0.001047
192.8	0.565559	54.096	6.887701	0.001049
192.9	0.565856	54.292	6.912656	0.001052
193	0.566163	54.488	6.937612	0.001055
193.1	0.56641	54.684	6.962567	0.001057
193.2	0.566774	54.88	6.987523	0.001061
193.3	0.566964	55.076	7.012478	0.001063
193.4	0.567269	55.272	7.037433	0.001066
193.5	0.567465	55.468	7.062389	0.001068
193.6	0.567775	55.664	7.087344	0.001071
193.7	0.567944	55.86	7.1123	0.001072
193.8	0.568265	56.056	7.137255	0.001076
193.9	0.568605	56.252	7.162211	0.001079
194	0.568859	56.448	7.187166	0.001082
194.1	0.568981	56.644	7.212122	0.001083
194.2	0.569293	56.84	7.237077	0.001086
194.3	0.569631	57.036	7.262032	0.001089
194.4	0.569818	57.232	7.286988	0.001091
194.5	0.570069	57.428	7.311943	0.001094
194.6	0.570454	57.624	7.336899	0.001098
194.7	0.570659	57.82	7.361854	0.0011
194.8	0.570948	58.016	7.38681	0.001103
194.9	0.571179	58.212	7.411765	0.001105
195	0.571464	58.408	7.43672	0.001108
195.1	0.571795	58.604	7.461676	0.001111
195.2	0.571982	58.8	7.486631	0.001113
195.3	0.572232	58.996	7.511587	0.001115
195.4	0.572548	59.192	7.536542	0.001119
195.5	0.572741	59.388	7.561498	0.00112
195.6	0.572995	59.584	7.586453	0.001123
195.7	0.573327	59.78	7.611409	0.001126
195.8	0.573477	59.976	7.636364	0.001128
195.9	0.573721	60.172	7.661319	0.00113
196	0.574088	60.368	7.686275	0.001134
196.1	0.574252	60.564	7.71123	0.001136
196.2	0.574471	60.76	7.736186	0.001138
196.3	0.574811	60.956	7.761141	0.001141
196.4	0.575089	61.152	7.786097	0.001144
196.5	0.575317	61.348	7.811052	0.001146
196.6	0.575561	61.544	7.836008	0.001149
196.7	0.575867	61.74	7.860963	0.001152
196.8	0.576111	61.936	7.885918	0.001154
196.9	0.576409	62.132	7.910874	0.001157
197	0.576637	62.328	7.935829	0.001159
197.1	0.576905	62.524	7.960785	0.001162
197.2	0.577208	62.72	7.98574	0.001165
197.3	0.577431	62.916	8.010696	0.001167
197.4	0.577716	63.112	8.035651	0.00117
197.5	0.577982	63.308	8.060606	0.001173
197.6	0.578253	63.504	8.085562	0.001176

197.7	0.578511	63.7	8.110517	0.001178
197.8	0.578761	63.896	8.135473	0.001181
197.9	0.579003	64.092	8.160428	0.001183
198	0.579261	64.288	8.185384	0.001186
198.1	0.579589	64.484	8.210339	0.001189
198.2	0.579794	64.68	8.235295	0.001191
198.3	0.580054	64.876	8.26025	0.001194
198.4	0.580363	65.072	8.285205	0.001197
198.5	0.580645	65.268	8.310161	0.001199
198.6	0.58094	65.464	8.335116	0.001202
198.7	0.581198	65.66	8.360072	0.001205
198.8	0.581423	65.856	8.385027	0.001207
198.9	0.581764	66.052	8.409983	0.001211
199	0.581971	66.248	8.434938	0.001213
199.1	0.582237	66.444	8.459893	0.001215
199.2	0.582473	66.64	8.484849	0.001218
199.3	0.582773	66.836	8.509804	0.001221
199.4	0.58304	67.032	8.53476	0.001223
199.5	0.583314	67.228	8.559715	0.001226
199.6	0.583597	67.424	8.584671	0.001229
199.7	0.583917	67.62	8.609626	0.001232
199.8	0.584144	67.816	8.634582	0.001234
199.9	0.584407	68.012	8.659537	0.001237
200	0.584724	68.208	8.684492	0.00124
200.1	0.585002	68.404	8.709448	0.001243
200.2	0.585305	68.6	8.734403	0.001246
200.3	0.585604	68.796	8.759359	0.001249
200.4	0.585874	68.992	8.784314	0.001252
200.5	0.586178	69.188	8.80927	0.001255

B.1.15 Elastic Modulus test results of SFRGC(K) at 800°C temperature.

Time	Absolute	Force	Stress	Strain
42.2	0.649041	0	0	0
42.3	0.649475	0.196	0.024955	4.34E-06
42.4	0.649965	0.392	0.049911	9.24E-06
42.5	0.650553	0.588	0.074866	1.51E-05
42.6	0.651107	0.784	0.099822	2.07E-05
42.7	0.651726	0.98	0.124777	2.68E-05
42.8	0.652311	1.176	0.149733	3.27E-05
42.9	0.652853	1.372	0.174688	3.81E-05
43	0.653455	1.568	0.199644	4.41E-05
43.1	0.654071	1.764	0.224599	5.03E-05
43.2	0.654741	1.96	0.249554	5.7E-05
43.3	0.655356	2.156	0.27451	6.32E-05
43.4	0.655983	2.352	0.299465	6.94E-05
43.5	0.656618	2.548	0.324421	7.58E-05
43.6	0.65721	2.744	0.349376	8.17E-05
43.7	0.657928	2.94	0.374332	8.89E-05
43.8	0.658693	3.136	0.399287	9.65E-05

43.9	0.659332	3.332	0.424242	0.000103
44	0.659937	3.528	0.449198	0.000109
44.1	0.660537	3.724	0.474153	0.000115
44.2	0.661143	3.92	0.499109	0.000121
44.3	0.661838	4.116	0.524064	0.000128
44.4	0.662557	4.312	0.54902	0.000135
44.5	0.663166	4.508	0.573975	0.000141
44.6	0.66382	4.704	0.598931	0.000148
44.7	0.664461	4.9	0.623886	0.000154
44.8	0.665069	5.096	0.648841	0.00016
44.9	0.665804	5.292	0.673797	0.000168
45	0.666455	5.488	0.698752	0.000174
45.1	0.667142	5.684	0.723708	0.000181
45.2	0.667796	5.88	0.748663	0.000188
45.3	0.668505	6.076	0.773619	0.000195
45.4	0.669234	6.272	0.798574	0.000202
45.5	0.669786	6.468	0.823529	0.000207
45.6	0.670433	6.664	0.848485	0.000214
45.7	0.671201	6.86	0.87344	0.000222
45.8	0.671891	7.056	0.898396	0.000229
45.9	0.672593	7.252	0.923351	0.000236
46	0.673142	7.448	0.948307	0.000241
46.1	0.673874	7.644	0.973262	0.000248
46.2	0.674512	7.84	0.998218	0.000255
46.3	0.675118	8.036	1.023173	0.000261
46.4	0.675797	8.232	1.048128	0.000268
46.5	0.67632	8.428	1.073084	0.000273
46.6	0.677006	8.624	1.098039	0.00028
46.7	0.677657	8.82	1.122995	0.000286
46.8	0.678329	9.016	1.14795	0.000293
46.9	0.678908	9.212	1.172906	0.000299
47	0.67961	9.408	1.197861	0.000306
47.1	0.680248	9.604	1.222816	0.000312
47.2	0.680872	9.8	1.247772	0.000318
47.3	0.681509	9.996	1.272727	0.000325
47.4	0.682168	10.192	1.297683	0.000331
47.5	0.682781	10.388	1.322638	0.000337
47.6	0.68338	10.584	1.347594	0.000343
47.7	0.683992	10.78	1.372549	0.00035
47.8	0.684664	10.976	1.397505	0.000356
47.9	0.685325	11.172	1.42246	0.000363
48	0.685941	11.368	1.447415	0.000369
48.1	0.686583	11.564	1.472371	0.000375
48.2	0.68726	11.76	1.497326	0.000382
48.3	0.687879	11.956	1.522282	0.000388
48.4	0.68851	12.152	1.547237	0.000395
48.5	0.689111	12.348	1.572193	0.000401
48.6	0.689723	12.544	1.597148	0.000407
48.7	0.69034	12.74	1.622103	0.000413
48.8	0.690958	12.936	1.647059	0.000419
48.9	0.691607	13.132	1.672014	0.000426
49	0.692321	13.328	1.69697	0.000433
49.1	0.693009	13.524	1.721925	0.00044
49.2	0.693658	13.72	1.746881	0.000446
49.3	0.694354	13.916	1.771836	0.000453

49.4	0.695012	14.112	1.796792	0.00046
49.5	0.695608	14.308	1.821747	0.000466
49.6	0.696253	14.504	1.846702	0.000472
49.7	0.696812	14.7	1.871658	0.000478
49.8	0.697449	14.896	1.896613	0.000484
49.9	0.698056	15.092	1.921569	0.00049
50	0.698566	15.288	1.946524	0.000495
50.1	0.699139	15.484	1.97148	0.000501
50.2	0.699718	15.68	1.996435	0.000507
50.3	0.700331	15.876	2.02139	0.000513
50.4	0.700889	16.072	2.046346	0.000518
50.5	0.701448	16.268	2.071301	0.000524
50.6	0.702042	16.464	2.096257	0.00053
50.7	0.70264	16.66	2.121212	0.000536
50.8	0.703219	16.856	2.146168	0.000542
50.9	0.70375	17.052	2.171123	0.000547
51	0.704332	17.248	2.196079	0.000553
51.1	0.704896	17.444	2.221034	0.000559
51.2	0.705485	17.64	2.245989	0.000564
51.3	0.706072	17.836	2.270945	0.00057
51.4	0.706608	18.032	2.2959	0.000576
51.5	0.707145	18.228	2.320856	0.000581
51.6	0.70767	18.424	2.345811	0.000586
51.7	0.708217	18.62	2.370767	0.000592
51.8	0.708807	18.816	2.395722	0.000598
51.9	0.709353	19.012	2.420677	0.000603
52	0.709857	19.208	2.445633	0.000608
52.1	0.710344	19.404	2.470588	0.000613
52.2	0.710911	19.6	2.495544	0.000619
52.3	0.711486	19.796	2.520499	0.000624
52.4	0.712018	19.992	2.545455	0.00063
52.5	0.71255	20.188	2.57041	0.000635
52.6	0.713089	20.384	2.595366	0.00064
52.7	0.713719	20.58	2.620321	0.000647
52.8	0.714357	20.776	2.645276	0.000653
52.9	0.714905	20.972	2.670232	0.000659
53	0.715462	21.168	2.695187	0.000664
53.1	0.715933	21.364	2.720143	0.000669
53.2	0.716498	21.56	2.745098	0.000675
53.3	0.717075	21.756	2.770054	0.00068
53.4	0.717613	21.952	2.795009	0.000686
53.5	0.718133	22.148	2.819964	0.000691
53.6	0.718665	22.344	2.84492	0.000696
53.7	0.719216	22.54	2.869875	0.000702
53.8	0.719701	22.736	2.894831	0.000707
53.9	0.72022	22.932	2.919786	0.000712
54	0.720732	23.128	2.944742	0.000717
54.1	0.721316	23.324	2.969697	0.000723
54.2	0.721922	23.52	2.994653	0.000729
54.3	0.722469	23.716	3.019608	0.000734
54.4	0.722994	23.912	3.044563	0.00074
54.5	0.723517	24.108	3.069519	0.000745
54.6	0.724104	24.304	3.094474	0.000751
54.7	0.724641	24.5	3.11943	0.000756
54.8	0.725174	24.696	3.144385	0.000761

54.9	0.725668	24.892	3.169341	0.000766
55	0.726137	25.088	3.194296	0.000771
55.1	0.726719	25.284	3.219251	0.000777
55.2	0.727232	25.48	3.244207	0.000782
55.3	0.727799	25.676	3.269162	0.000788
55.4	0.728298	25.872	3.294118	0.000793
55.5	0.728822	26.068	3.319073	0.000798
55.6	0.729374	26.264	3.344029	0.000803
55.7	0.729906	26.46	3.368984	0.000809
55.8	0.730523	26.656	3.39394	0.000815