STUDY ON BINARY AND TERNARY BLENDED CONCRETE UNDER ELEVATED TEMPERATURE

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Abstract

In the present investigation, a feasibility study is made to utilize the Fly ash and Rice Husk Ash and as anadmixture in concrete and to investigate the impact of elevated temperatures on the properties of concrete. The proportions of water, cement, fine aggregate and coarse aggregate with we can prepared control mix binary mix (77% cement+23% fly ash) and (80% cement+20% rice husk ash) and ternary concrete(68% cement+23% fly ash+9% silica fume) and (71% cement+20% rice husk ash+9% silica fume) and grade of concrete is M 2 0 , M 30 and M40. In this study we are tested at room temperature and exposed to 100, 200,300,400,500, 600 °C temperatures for 1 hour. The specimens were exposed under the same condition for each temperature level. All specimens were moist cured for28 days after casting.The specimens were tested for compressive strength. Use o fly ash and rise husk ash in concrete not only reduces cost but also improves resistance against elevated temperatures and durability. After exposure to elevated temperature was increased by increased fly ash and rice husk ash, The utilization of Rice Husk Ash (RHA) in concrete is environmental friendly and reduces the carbon dioxide emission.

Key words : Ternary concrete ,compressive strength, binary blended concrete, RHA, control concrete, Temperature

Introduction

Concrete is a widely used building material in many different structures, such as homes, commercial buildings, roads and bridges. Underground structures and riverbank structures. Concrete is a composite material made with aggregates, cement, water and, in some cases, additives. Concrete must be strong enough to support overlapping loads, impermeable and durable throughout its expected life. Therefore, the manufacture of structures and concrete products requires careful administration of a mixture of cement, water, aggregates and additives to achieve optimum quality and economy.

Fly ash

Fly ash is a fine gray powder mainly composed of spherical glassy particles that are a by-product of coal-fired power plants. Fly ash has pozzolan properties. In other words, it reacts with lime to form cement compounds. It is commonly known as an auxiliary cement material.

Rice husks Ash

Rice husks are agricultural residues that make up 20% of the 649.7 million tonnes of rice produced annually worldwide. Partial combustion shells produced from grinders also cause environmental pollution when used as fuel, and efforts are being made to solve this environmental problem by using this material as an additional cement material. It is known that the chemical composition of rice husks varies from sample to sample due to differences in paddy field type, harvest year, climate, and geographical conditions. Rice husk ash (RHA) is a high-quality pozzolan material.

Silica fume

Silica fume is a mineral mixture composed of amorphous silica submicron particles (100-150th of cement particles). Silica powder is a gray to off-white color and is available in a variety of product forms and packaging options.

Objective

To compare the compressive strength of control mix, binary concrete and ternary concrete at different elevated temperature

literature review

MOHAMMED KADHIM HALOOB (2016) The high temperature of the characteristics of concrete. ACI has achieved a maximum size of 20 mm and a concrete quality of 30 MPa for water, cement, fine aggregate and coarse aggregate ratios. 5%, 10%, 20%, and 30% of cement are replaced by rice husk ash by weight so that research can reach the optimal alternative. They are tested at room temperature and exposed to temperatures of 200, 400, 600 and 800 ° C for 1 hour. The sample was exposed to the same conditions at each temperature level. All samples were wet cured for 28 days after casting. The samples were dried in an electric oven at a temperature of 105 ° C for 24 hours before exposure to high temperatures. The test was performed on a sample that was slowly cooled to room temperature after being exposed to high temperatures. The sample is compressive strength, split strength.

Gnanasoundarya S et al (2017) This work covered a study of the performance of TBC using silica fume (SF) and metakaolin (MK) as pozzolanic materials for 1 hour at 200 ° C intervals at high temperatures of 200 ° C to 800 ° C. Various tests such as compressive strength test, split tensile test, acid attack test, chloride permeability test were performed with TBC blend and compared with the behavior of non-heated blend. While changing the ratio of MK to 5%, 10%, 15%, and 20%, the mechanical properties and durability were investigated with the SF substitution of 10% as a constant. Test results show that the 10% SF and 15% MK blends have better mechanical and durability than other blends at high temperatures.

Materials and Methods

- Cement
- Sand
- Aggregate
- Fly ash
- Rice husk ash
- Silica Fume

- Water

Table 1 Mix proportions for control concrete

Concrete grade	Materials required per m^3 of concrete			
	Cement (kg)	Sand (kg)	Coarse Aggregate (kg)	Water (Liter)
M 20	422	680	1137	190
M 30	440	736	1032	197
M 40	445	742	1011	200

- ✓ Table 1 Showing the Quantity of Different Grade of plain concrete.
- ✓ These quantity are $1m^3$

Table 2 Fly ash Cementations material combinations for binary blended concrete and ternary concrete

Mix Designation	Cement content kg/m^3				FA content kg/m^3			
	%	M 20	M 30	M 40	%	M 20	M 30	M 40
PCC	100	422	440	445	0			
BFA-23	77	324.94	338.8	342.65	23	97.06	101.2	102.35
SF9	68	295.7	308.31	311.82	9	29.24	30.49	30.83

- ✓ Table 2 showing the quantity of fly ash and cement including different % of replacement .
- ✓ Cement has been replaced with Fly Ash 5% to 25%

Table 3 Rice Husk Ash Cementations material combinations for binary blended concrete

Mix Designation	Cement content kg/m^3				RH content kg/m^3			
	%	M 20	M 30	M 40	%	M 20	M 30	M 40

PCC	100	422	440	445	0			
BRH - 20	80	337.6	352	356	20	84.4	88	89
SF9	71	307.22	320.32	323.96	9	30.38	31.68	32.04

- ✓ Table 3 showing the quantity of Rice husk ash and cement including different % of replacement .
- ✓ Cement has been replaced with rice husk ash 5% to 25%.

Result and Discussion

Effect of Temperature in Ternary blended concrete

Sturdiness of concrete can be defined as the ability of concrete to resist weathering action, chemical assault, and abrasion whilst retaining its desired engineering residences. Temperature version will motive modifications within the concrete volume. Whilst the temperature increases the volume of the concrete will increase and when the temperature falls the concrete contracts.

If the concrete is unrestricted then the quantity adjustments will no longer do too much effects but generally the concrete usually limited via foundations, reinforcement or connecting contributors, due to this the trade in extent will produce extensive strain in concrete and which can purpose crack.

Temperature greater than 95 degree Celsius may have vast effect on concrete .the total volume alternate in concrete is the sum of the extent adjustments of the cement paste and urban. At high temperature, the cement paste will reduce because of dehydration of calcium silicate hydrate(C-S-H), even as the aggregate will expand. for normal mixture concrete, there may be net growth.

Consequently, publicity to high temperature specially fire will result in crack in concrete but the time of exposure should sufficiently high.

Table 4.13 Compressive strength for Ternary blended concrete (Fly Ash + cement+ silica fume) at different temperature for M20 @ 1 hours

Mix	**compressive strength (N/mm^2)**					
	M 20					
	100^{0}C	**200^{0}C**	**300^{0}C**	**400^{0}C**	**500^{0}C**	**600^{0}C**
PCC	27.71	25.85	23.85	21.13	20.17	16.60

BFA-23	27.10	26.65	24.67	25.52	25.81	20.47
SF3	27.42	26.85	24.86	25.17	25.90	21.65
SF6	27.87	27.78	25.17	25.47	24.89	21.28
SF9	29.08	28.69	26.14	28.28	28.68	26.87
SF12	25.92	23.60	21.41	21.73	20.17	19.14

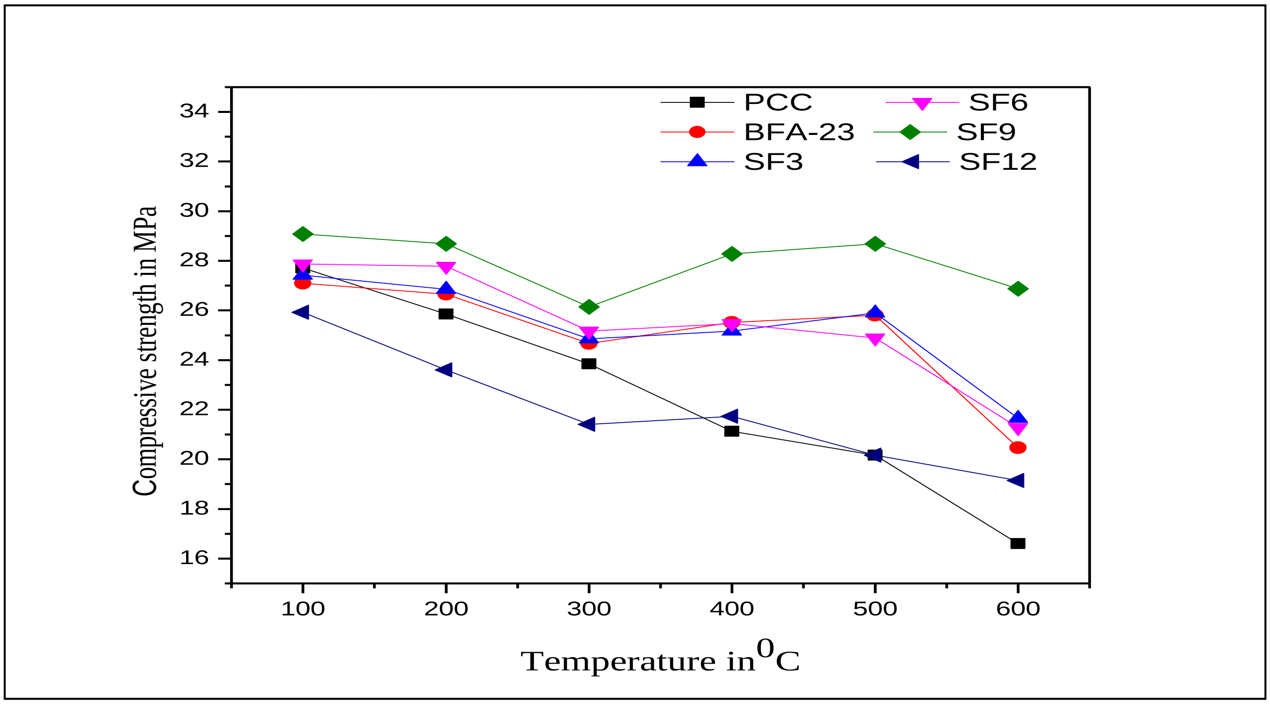

Figure 4.15 Compressive strength for Ternary blended concrete (Fly Ash + cement+ silica fume) at different temperature for M20 @ 1 hours

Table 4.14 Compressive strength for Ternary blended concrete (Fly Ash + cement+ silica fume) at different temperature for M30 @ 1 hours

Mix	compressive strength (N/mm^2)					
	M 30					
	100^{0}C	200^{0}C	300^{0}C	400^{0}C	500^{0}C	600^{0}C
PCC	36.12	34.74	34.12	32.45	31.87	26.16
BFA-23	37.12	35.17	34.88	33.79	32.16	28.62
SF3	37.34	35.98	34.91	33.89	33.12	29.60
SF6	38.10	36.24	35.89	35.11	34.90	30.18

SF9	39.12	39.06	38.91	38.60	38.92	30.16
SF12	35.24	34.58	33.60	32.16	31.10	28.16

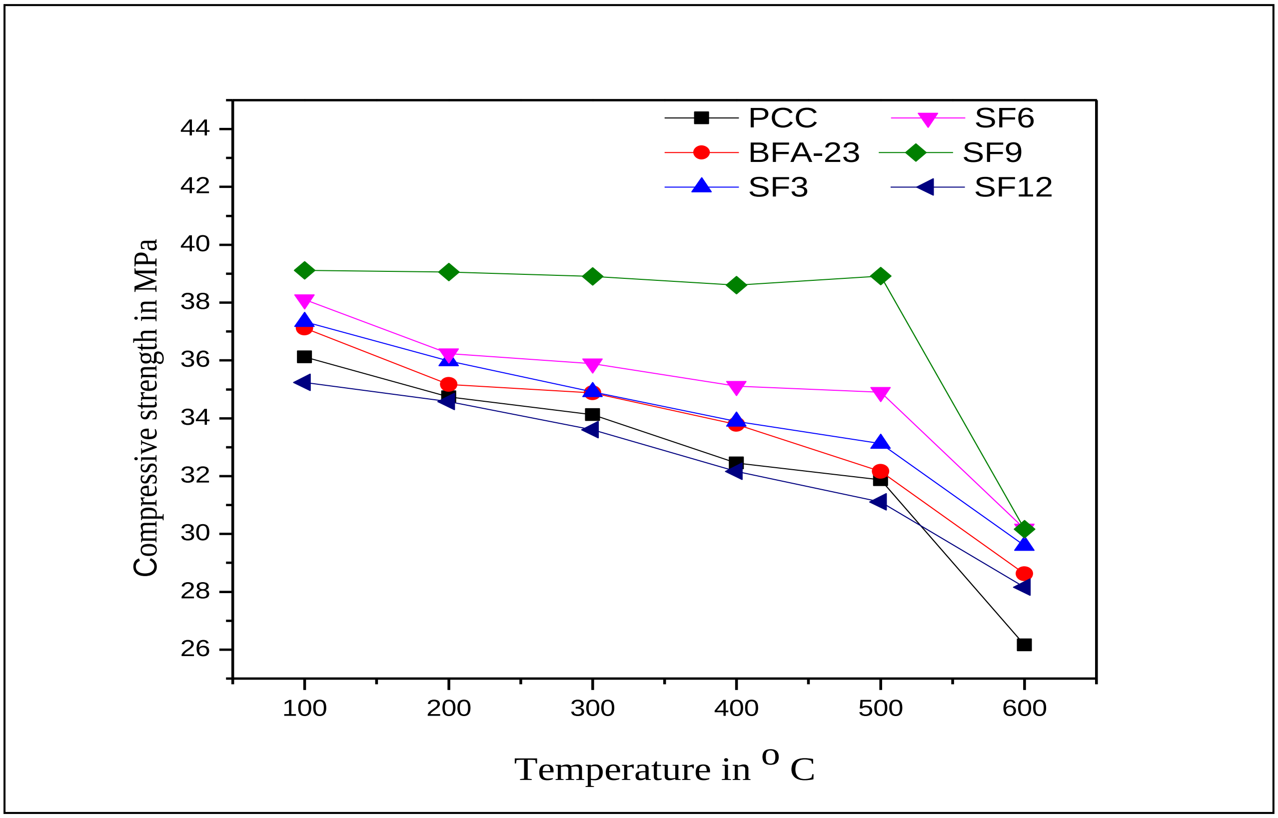

Figure 4.16 Compressive strength for Ternary blended concrete (Fly Ash + cement+ silica fume) at different temperature for M30 @ 1 hours

Table 4.15 Compressive strength for Ternary blended concrete (Fly Ash + cement+ silica fume) at different temperature for M40 @ 1 hours

Mix	compressive strength (N/mm^2)					
	M 40					
	100^0C	**200^0C**	**300^0C**	**400^0C**	**500^0C**	**600^0C**
PCC	53.17	51.85	51.11	50.42	48.23	45.62
BFA-23	48.13	48.23	47.89	46.28	46.84	45.36
SF3	49.63	48.71	47.23	46.89	46.12	42.33
SF6	49.82	48.87	47.69	46.92	47.90	44.23
SF9	50.23	49.89	49.23	48.35	48.90	44.23
SF12	47.23	46.17	45.57	45.02	43.28	40.28

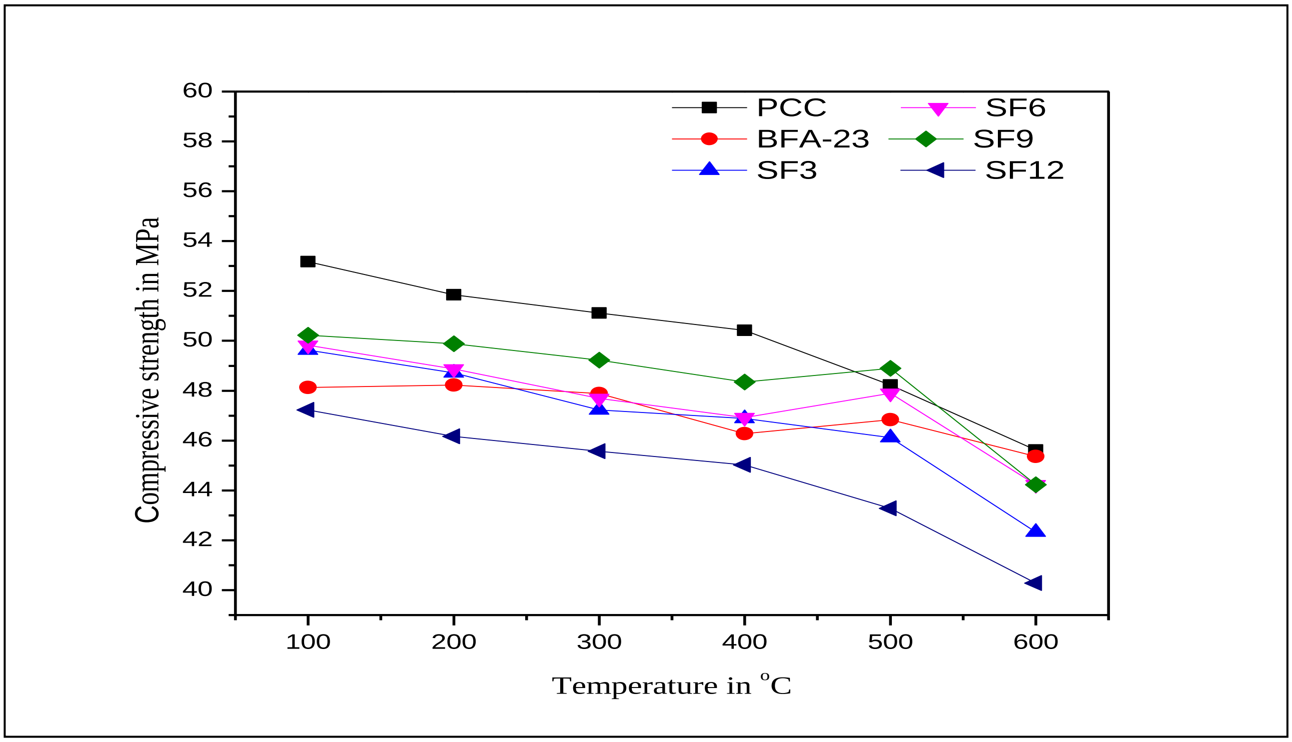

Figure 4.17 Compressive strength for Ternary blended concrete (Fly Ash + cement+ silica fume) at different temperature for M40 @ 1 hours

The problem of fire is normal in today's time and we should use those materials which are fire desert, not completely but for some time We tested different grades of concrete at different temperatures After 28 Days

We kept all grade of concrete after 28 days at different temp for 1 hour and we found that

As the temperature increased, the strength of the control concrete decreased. similarly the strength of the binary concrete decreased. But the strength of the ternary concrete changed to a replacement value of SF9

- ✓ We checked the compressive strength of all grade of concrete after 28 days and we found that the strength of M20, M30 and M40 grade of control mix concrete was 27.71Mpa 36.12MPa and 53.17MPa at 100ºC.
- ✓ Whilst cement turned into replaced by way of silica fume from 3% to 12%, the compressive energy show excellent at SF9 add in binary concrete.
- ✓ The outcomes of M20, M 30 and M 40 grade concrete with diverse alternative levels are also shown in Table 4.1 and Figures 4.13, 4.14 and 4.15 respectively.
- ✓ SF9 is showing good results in every grade of concrete in 500ºc temperature M20 ,M30 and M40 is 28.68Mpa, 38.92Mpa and 48.90MPa

This proves that ternary concrete has good temperature resistance in comparison with normal mix and binary mix.

Table 4.16 Compressive strength for Ternary blended concrete (Rice Husk Ash+ cement+ silica fume) at different temperature for M20

Mix	compressive strength (N/mm^2)					
	M 20					
	100^{0}C	**200^{0}C**	**300^{0}C**	**400^{0}C**	**500^{0}C**	**600^{0}C**
PCC	28.81	27.55	26.79	25.13	24.43	22.17
BRH - 20	27.32	**26.17**	**25.64**	**24.18**	**23.27**	20.14
SF3	25.37	**24.92**	**22.18**	**21.74**	**20.60**	19.23
SF6	26.66	**25.84**	**25.84**	**23.21**	**23.42**	18.17
SF9	27.42	**26.17**	**26.07**	**25.17**	**25.17**	18.61
SF12	26.12	**24.12**	**23.87**	**22.12**	**21.47**	16.13

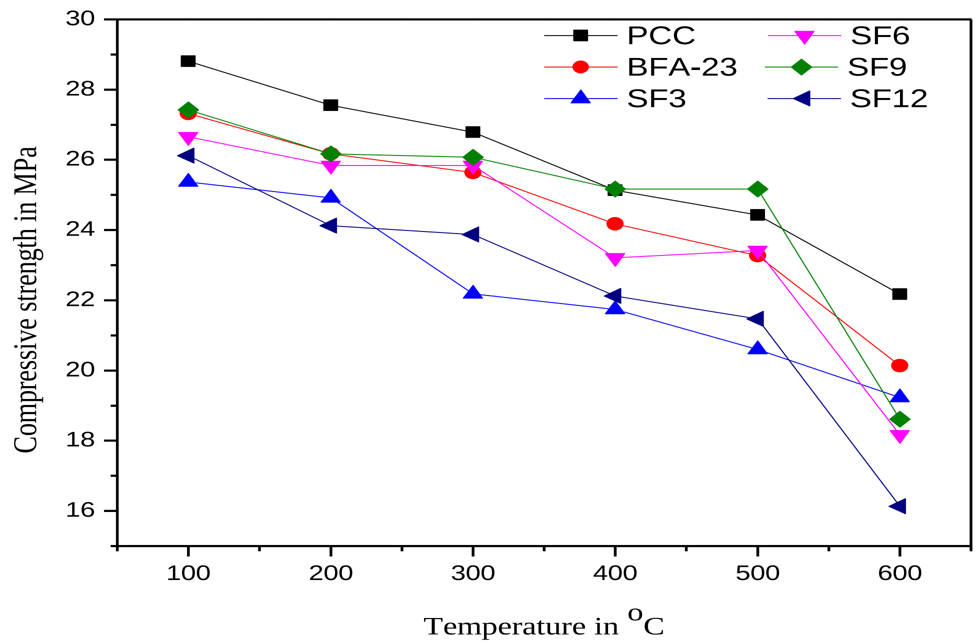

Figure 4.18 Compressive strength for Ternary blended concrete (Rice Husk Ash+ cement+ silica fume) at different temperature for M20

Table 4.17 Compressive strength for Ternary blended concrete (Rice Husk Ash+ cement+ silica fume) at different temperature for M30

Mix	compressive strength (N/mm^2)					
	M 30					
	100^{0}C	**200^{0}C**	**300^{0}C**	**400^{0}C**	**500^{0}C**	**600^{0}C**
PCC	40.13	39.21	38.58	37.04	36.23	34.17
BRH - 20	38.23	**37.12**	**36.77**	**35.92**	**35.23**	31.70
SF3	37.16	**36.10**	**35.45**	**34.94**	**33.17**	29.27
SF6	37.34	**36.87**	**34.27**	**33.17**	**32.23**	28.64
SF9	39.17	**38.25**	**37.53**	**38.57**	**39.22**	33.27
SF12	36.14	**35.11**	**33.85**	**32.60**	**32.24**	27.14

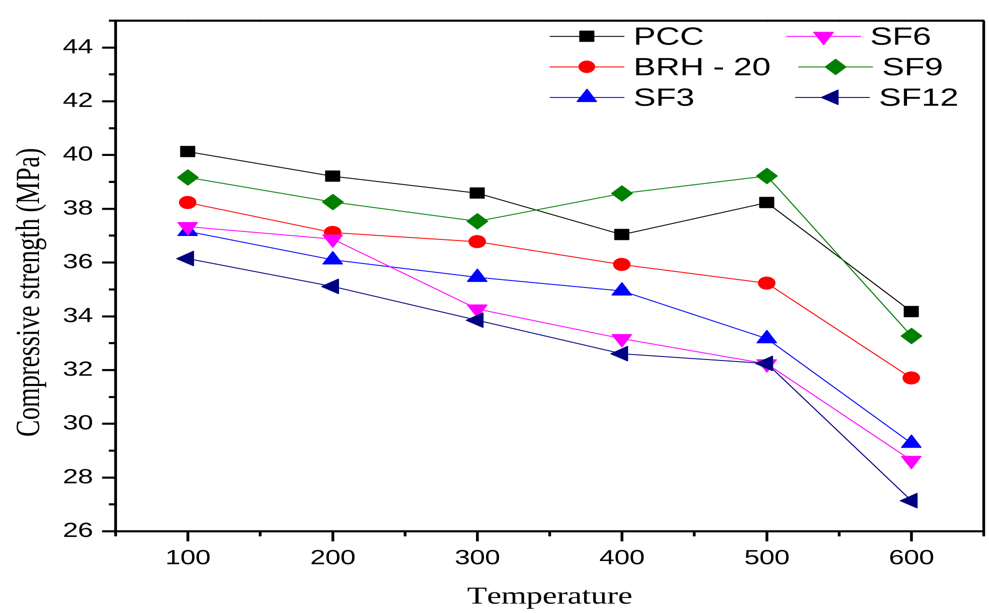

Figure 4.19 Compressive strength for Ternary blended concrete (Rice Husk Ash+ cement+ silica fume) at different temperature for M30

Table 4.18 Compressive strength for Ternary blended concrete (Rice Husk Ash+ cement+ silica fume) at different temperature for M40

Mix	compressive strength (N/mm^2)					
	M 40					
	100^{0}C	200^{0}C	300^{0}C	400^{0}C	500^{0}C	600^{0}C
PCC	53.33	51.12	50.60	49.07	48.26	46.76
BRH - 20	**48.81**	**47.15**	**47.56**	**46.33**	**46.23**	45.12
SF3	**47.51**	**47.86**	**46.43**	**45.11**	**45.05**	43.47
SF6	**48.42**	**47.53**	**47.14**	**46.47**	**46.02**	41.85
SF9	**49.27**	**49.12**	**48.83**	**48.26**	**48.06**	40.24
SF12	**46.36**	**45.85**	**44.25**	**44.25**	**43.64**	39.20

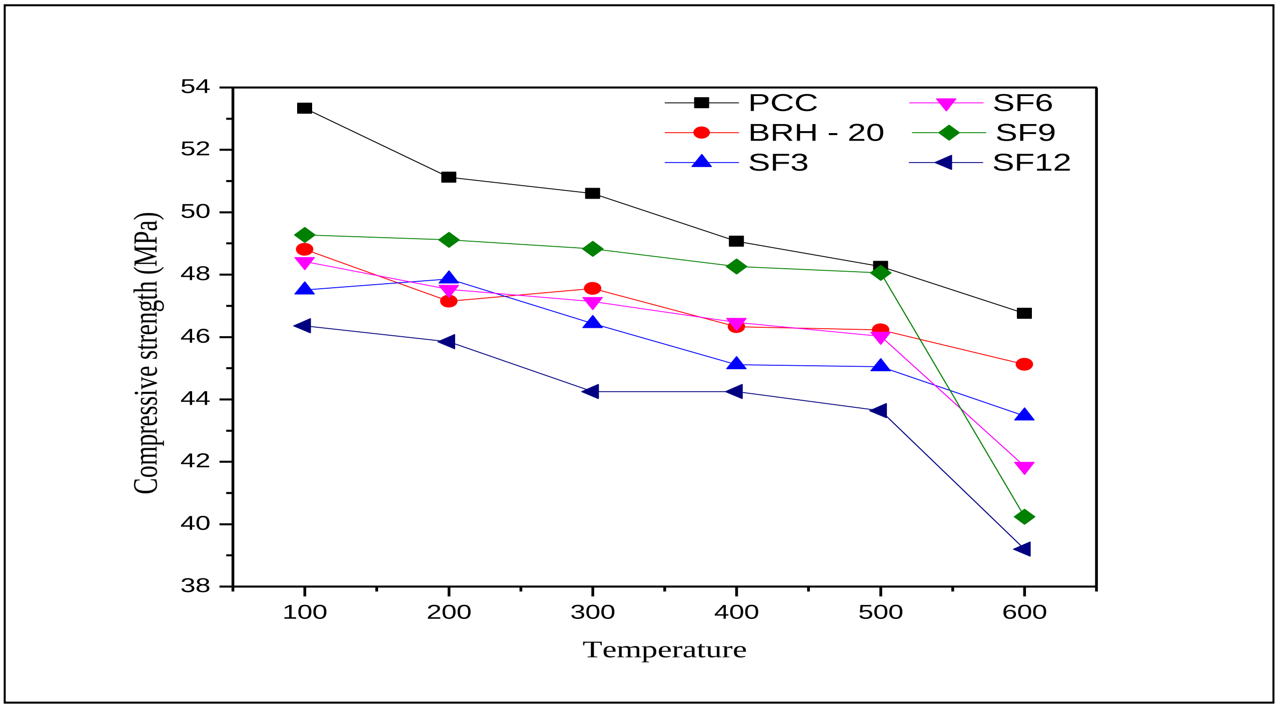

Figure 4.20 Compressive strength for Ternary blended concrete (Rice Husk Ash+ cement+ silica fume) at different temperature for M40

Conclusion

In this chapter, all the findings obtained from the research will be concluded. Basically, the research investigated the suitability of Fly ash (FA) Rice Husk Ash (RHA) and silica fume as partial cement replacement in concrete in moist curing condition and at elevated temperature exposure. Based on the results comparing these with the control mixture, binary blended concrete and ternary concrete the following conclusions can be drawn.

- ✓ We checked the compressive strength of all grade of concrete after 28 days and we found that the strength of M20, M30 and M40 grade of control mix concrete was 27.71Mpa 36.12MPa and 53.17MPa at 100ºC. fl
- ✓ Whilst cement turned into replaced by way of silica fume from 3% to 12%, the compressive energy show excellent at SF9 add in binary concrete.
- ✓ SF9 is showing good results in every grade of concrete in 500ºc temperature M20 ,M30 and M40 is 28.68Mpa, 38.92Mpa and 48.90MPa fly ash ternary concrete and rice husk based ternary concrete 24.43MPa, 39.22MPa and 48.06MPa

References

1.ASTM C 33 . Standard Specification for Concrete Aggregates. ASTM International.
2.ASTM C 78 .Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).ASTM International.

3.Pierre-Claude Aitcin, Allen J. Hulshizer, H. Celik Ozyildirim, "Guidelines for the Use of Silica fume in Concrete", reported by American Concrete Institute Material Journals, Committee Report 234(2000).

4.A. K. H. Kwan, J. J. Chen, W. W. S. Fung, and P. L. Ng, "Effects of Silica Fume on Heat Generation of Curing Concrete", American Concrete Institute Material Journals V. 108, No. 6, November-December 2011.

5.Ali Behnood , Hasan Ziari , "Effects of Silica fume Addition and Water-to-Cement ratio on the Properties of High Strength Concrete After Exposure to High Temperatures", Elsevier , Cement & Concrete Composites 30 (2008) 106–112.

6.Omer Arioz, "Effects of Elevated Temperatures on Properties of Concrete", Elsevier, Fire Safety Journal 42 (2007) 516–522.

7.El-Hadj Kadri , Said Kenai , Karim Ezziane, Rafat Siddique , Geert De Schutter, "Influence of Metakaolin and Silica Fume on the Heat of Hydration and Compressive Strength Development of Mortar", Elsevier , Applied Clay Science 53 (2011) 704–708.

8.K.A.Guber , "Increasing Concrete Durability with High Reactive Metakaolin", Elsevier, Cement and Concrete Composites 23 (2011) 479 -484.

9.K. Sakra, E. EL Hakimb, "Effect of high temperature or fire on heavy weight concrete properties", Elsevier, Cement and Concrete Research 35 (2005) 590–596.

10.Ivan Janotka , Terezia N¨urnbergerov, "Effect of temperature on structural quality of the cemen paste and high-strength concrete with silica fume", ELSEVIER, Nuclear Engineering and Design 235 (2005) 2019–2032.

11.mohammed al-majidi "effects of exposure to elevated temperatures on properties ofconcrete containing rice husk ash**"**