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Effect on properties of ferrocement blended geopolymer element due to thermal impact

Efectos en las propiedades de elemento de geopolímeros mezclados con ferrocemento debido al impacto térmico

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Abstract

Scope of study is to evaluate durability characteristics of ferrocement blended geopolymer mortar after subjected to fire. ferrocement element is made of geopolymer mortar and its fire resistance behaviour is compared with the conventional ferrocement element made of cement mortar. Previously, the molar concentration of sodium hydroxide solution used for preparing geopolymer mortar is standardized by finding the residual strength of mortar cubes prepared by various NaOH concentrations. The residual flexural strength of Ferro-geopolymer concrete and normal Ferrocement specimens of various volume fractions (1.5 %, 1.8 %, 2.1%) are exposed to three different temperature levels for two hours from 300 degree Celsius to 900 degrees Celsius are determined and compared. For the same volume fractions, the specimens are exposed to elevated temperature of 900ºc to find the residual impact strength. The fire resisting characters in terms of residual flexural strength, residual impact strength and loss of weight after fire exposure are determined. In all aspects, Ferro-geopolymer concrete shows superior performance than the conventional ferrocement.

Keywords: Fire resistance; ferrocement concrete; geopolymer concrete; flexural strength; temperature of concrete.

Resumen

Este estudio evalúa las características de la durabilidad del ferrocemento mezclado con mortero de geopolímeros después de ser sometido al fuego. El ferrocemento fue preparado con mortero de geopolímeros y se comparó con el ferrocemento convencional preparado solo con mortero de cemento. Previamente, se estandarizó la concentración molar de la solución de hidróxido de sodio usada para preparar el mortero de geopolímeros mediante la resistencia residual de los cubos de mortero preparados con diversas concentraciones de NaOH. Se determinó y comparó la resistencia residual a flexión de probetas de hormigón preparadas con diferentes porcentajes en volumen (1,5%, 1,8% y 2,1%) de ferro-geopolímeros y ferrocemento, las que luego fueron sometidas durante dos horas a tres niveles de temperatura entre los 300°C y 900°C. Además, probetas con los mismos porcentajes en volumen fueron expuestas a temperaturas sobre los 900°C con el objetivo de determinar su resistencia residual al impacto. Se determinaron las características de la resistencia al fuego de las probetas en términos de Resistencia residual a flexión, resistencia residual al impacto y pérdida de peso. En todos los aspectos, las probetas preparadas con ferro-geopolímeros mostraron un comportamiento superior a las probetas convencionales de ferrocemento.

Palabras clave: Resistencia al fuego; hormigón de ferrocemento; hormigón de ferro-geopolímeros; resistencia a flexion; temperatura del concreto.

1. Introduction

Fire resistance of construction is most important research are in current century. There are many studies which concentrate enhancement of concrete firefighting capacity covered with tubes steel and natural zeolites and other special materials (Min Yu et al., 2020) : (Alexandra et al., 2021) : (Shan Li et al., 2021). Under extreme fire scenarios, this large temperature creep strain may control deformation retort and appropriately accounted for fire resistance learning (Kodur, 2021). furnace temperature improved 400 °C to 600 °C, compressive strength decreased. Foam concrete with ceramic and MA has a high potency on fire confrontation than regular concrete (Awoyera., 2020). Due to thick and dense microstructure, high performance FRC beams be particularly vulnerable due to fire-induced spalling (Srishti et al., 2020). The temperature in reinforcing steel bars was unaffected by section magnitude reduction in element until 90 minutes after exposure to fire (Fabrício Longhi Bolina et al., 2020). As the temperature rises, FRC tensile strength goes down. With steel fiber FRC's tensile property is higher than that of FRC without steel fibres (Heyang et al., 2020). Compressive strength decreased as temperature increased, whereas residual strength increased (Binmeng et al., 2020). Post-earthquake fire prevention will be lower in RC structures that have suffered moderate/severe earthquake damage (HugoVitorino et al., 2020). Incorporating 0.25 percent MWCNTs and 0.2 percent PP fibers into composite, high fire confrontation cement mortar might be made (Peem et al., 2021). Under extreme fire exposures, the degree of spalling impact on concrete beams fire resistance (Venkatesh et al., 2021).

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When exposed to fire and high temperatures, 1 percent CFC had a higher compressive strength than the other blends (Khaleel et al, 2021). SRCFST fire resistance exposed to three sided & four found identical, but their failure modes were substantially different (Meng et al., 2020). The use of UHSC improves CFST columns fire confrontation (Xiong and Richard, 2021). After exposing cement mortars with mineral wool to fire the thermal conductivity has decreased or remained unchanged (Piña Ramírez et al., 2020). EAFS improves the properties of concrete as well as its fire resistance (Yousef et al., 2020). In most cases, high temperature exposure does not spontaneously ignite reinforced concrete (Wróblewska and Kowalski, 2020). Temperature spreading inside slab was not constant because of free water evaporation (Del Coz Díaz et al., 2020). The thermal stability of the composite containing OPC-10WGP-0.5NMF was increased (M. Ramadan et al., 2020). additional heat protection offered by the increased concrete cover was beneficial to the rebars (Rosa et al., 2020). After being exposed to heat, the SRC column's compression resistance decreased by 4% (Han et al., 2020). cement composites thermal conductivity in starting decreases and later increases as content of CEPS particles increases (Zhengzhou et al., 2020). The usage of materials that could delay temperature rise at bottom steel is increase fire bending capability (Albero et al., 2020). The integration of NSF improved the flexural behaviour of ferrocement element (Dawood et al., 2021). ferrocement overlay injected into the grout gives best ultimate and residual performance compared to URM (.Xin et al., 2021). ferrocement help improvement of impact and heat resistance (Mohd. et al., 2021). Fire prevention was well when adopting ferrocement jacket (Greepala et al., 2008). When fire exposed, in the range of 25%-75 percent impact resistance of all ferrocement panels was reduced (Atta, 2018). light weight polymer made with pumice and smashed clay LWGCs had greater thermal insulation (Wongsa et al., 2018). The addition of SiO2-rich materials to geopolymer concretes reduced the post-fire residual strength (Nuaklong et al., 2020). Geopolymer has equivalent possessions comparing OPC concrete in different Heat (Zhang et al., 2018). As rubberized geopolymer concrete is exposed to high temperatures, it loses strength (Luhar et al., 2018). GPC have better fire protection and chemical Resistance (Hassan et al., 2019). GPC retains its strength until 800 °C (Hassan, et al., 2020). Geopolymer-based binders have an intrinsic advantage in terms of fire resistance (Mukund et al., 2019). ductility of GPC beams decreases quickly as acquaintance temperature rises (Mathew and Joseph, 2018). GPC with high volume rubber substitution had a high level of toughness (Dong et al., 2021). GPC with fly ash have very less chloride dispersion battle (Noushini et al., 2020). In terms of mass loss, a surface covering with polyvinyl alcohol FRGPC greatly lowered corrosion damage (Al-Majidi et al., 2018). K- based GPC have less surface cracking Due to CF bridging cracks (Shaikh et al., 2019). When the GFC20EP is used as a building element, the thermal efficiency tests performed using prototype test cells show that the indoor thermal conditions can dramatically improve (Pasupathy et al., 2020). The calcium content has a significant impact on the process of durability (Chen et al, 2021). Due to reinforcement corrosion, FRGPC bond potential reduced (Nabeel et al., 2018). Until 300 °C, compression stableness increasing regardless but with help of additive worn (Kantarci et al, 2021). Our objective of experimental work is optimizing effect on fire with the blended ferro-geopolymer concrete and analyse several fire resistance physiognomies of ferro-geopolymer elements, such as residual flexural strength, residual impact strength, and weight loss after fire exposure.

2. Methodology

In this investigation, initially the geopolymers are prepared for various molar concentration of sodium hydroxide from 8M to 14M. After the fire exposure extend from 300°c up to 900°c, the residual compressive strength of those mortar cubes was compared. sodium hydroxide molar concentration to be used for geopolymer mortar preparation is standardized. From the preliminary results, 10 Molar concentration of sodium hydroxide is performed well and which is used to prepare geopolymer mortar for the ferrocement casting. The ferrocement is prepared both by geopolymer mortar and cement mortar. The main parameter discussed in experimental work is the volume fraction. Three types of volume fraction of 1.5%, 1.8%, 2.1% are used in this project. The specimens are exposed up to 900°c and then tested for flexure and impact strength.

3. Material used and properties

3.1 Cement

Ordinary Portland cement 53 grade having cohesive and adhesive property used as a binding material in this work confirmed to code (IS 12269, 1987). The chemical composition and Physical properties of cement used for this work is given in (Table 1) and (Table 2) respectively.

Table 1. Chemical composition of cement

Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	SO_3	Na_2O	LOI
Mass (%)	19.9	4.70	3.38	63.93	1.30	0.45	2.54	0.17	2.97

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Table 2. Physical properties of cement

S. No	Characteristics	Obtained Value
1	Specific gravity	3.16
2	Consistency	32%
3	Initial and Final setting Time	34min & 255 min

3.2 Geopolymer

To made a special concrete for resisting fire we used polymer mortar which is consisting Pozzolans (Fly ash), Activator solution, Alkali powder, water reducing Lignosulphonate normal Super Plasticizer and distilled water.

3.3 Fly ash

We collected Class-F Fly ash is formed from coal from sterlite industry, Tuticorin to use as replacement material for cement confirms to code (IS 1489, 1991 (Part 1),). fly ash chemical proportions given (Table 3).

Table 3. Physical properties of cement

Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	TiO_2	SO_3	Na_2O
Mass (%)	65.4	20.67	6.18	1.26	0.82	-	-	Trace	-

3.4 Activator Solution

The silicates and hydroxides of water soluble high alkaline Sodium is utilized in this investigation. hydroxide solution is prepared to a specified concentration using NaOH in flakes and Potable water. To attain maximum performance in strength aspect we used 0.67 to 1 range Sodium silicate to sodium hydroxide.

3.5 Fine aggregate

For geopolymer mortar and cement mortar mixes we used locally available river sand, which have 2.65 as specific gravity confirmed to code (IS 383, 1970) and (IS 2386, 1963 (Part 3)).

4. Geopolymer and cement mortar mix

The geopolymer specimen consist calcium low fly ash with a alkaline sodium hydroxide/sodium silicate solution. Mix design details of mortar made of geopolymer and cement used was given in (Table 4)

Table 4. Mix detail for Geopolymer and cement mortar

Specimen	Cement	8-Molarity	10-Molarity	12-Molarity	14-Molarity
No. of Specimens	12	12	12	12	12
Cement(Kg.)	4.44	-	-	-	-
Sand(Kg.)	4.44	4.44	4.44	4.44	4.44
Flyash (Kg.)	-	3.312	3.312	3.312	3.312
NaOH(Kg.)**(1:1 Ratio)**	-	0.324	0.324	0.324	0.324
Na_2SiO_3(Kg.)**(1:1 Ratio)**	-	0.828	0.828	0.828	0.828
Water (Kg.)	1.32	-	-	-	-
Super Plasticizer (Kg.)	-	0.033	0.066	0.088	0.111
Name of Mix	M1	G1	G2	G3	G4

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5. Experimental investigation

For each molarity, 12 mortar cubes were prepared and exposed to fire around 900o C then compressive strength of those cubes tested. The best three we taken for analysis and discussion.

5.1 Fire exposure

The cube specimens are exposed to the high temperature (900o C). Temperature increase is 5°c per minute at a constant rate. After 2 hrs the exposed specimen are allowed to cool at normal room temperature with reference (IS 1641, 1988) and (IS 1642, 1989). Cubes exposed to fire before testing of compressive strength is shown in (Figure 1).

Figure 1. Fire exposure of Cube specimens

5.2 Compresive strength of cubes after exposed to fire

Standard UTM used for testing compression strength. Geopolymer mortar exposed at 900ºC shows comparatively better results than cement mortar. The 10M concentration shows better results than that of the other mixes. The test procedure followed as per code (IS 516, 1959) . The results are given in (Table 5).

Table 5. Compression strength of various mortar cubes

SAMPLE	M1(MPa)	G2(MPa)	G3(MPa)	G4(MPa)	G5(MPa)
1	38.02	38.01	52.02	24.01	44.01
2	47.02	44.01	56.01	22.01	36.01
3	41.01	36.01	50.01	20.01	28.01

5.3 Ferrocement Specimen

From the preliminary test, it is found that 10M concentration gave better results for fire resistance. The ferrocement specimen should be cast with both cement mortar and geopolymer mortar. The specimens are allowed for flexural test and impact test. The main parameter discussed here is volume fraction of the reinforcement used. Hence, specimens are separately cast for impact and flexure test. The reinforcement mesh used is rectangular welded mesh of 3mm thickness with longitudinal spacing of 80mm and transverse side spacing of 35 mm. The hexagonal chicken mesh is also used to wrap over the welded mesh to enhance its bonding to the mortar. Three types of volume fraction of 1.5%, 1.8%, 2.1% are used here as reinforcement. The type of mesh, its combination and the volume fraction used are tabulated in (Table 6).

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Table 6. Specimen details

S.No	Specimen ID	Type of mesh used	Volume fraction (%)	Set of specimen	
				Flexure	Impact
1	FW1C1	1 layer weld mesh -1 layer Chicken mesh	1.5	8	4
2	FW1C2	1 layer weld mesh -2 layer Chicken mesh	1.8	8	4
3	GW2	2 layer welded mesh	2.1	8	4
4	GW1C1	1 layer weld mesh- 1 layer Chicken mesh	1.5	8	4
5	GW1C2	1 layer weld mesh and 2 layer Chicken mesh	1.8	8	4
6	GW2	2 layer welded mesh	2.1	8	4

5.4 Casting of ferrocement specimen

The size of the ferrocement specimen used is 230mm X 230mm. The thickness of the specimen is 25mm. The prepared mortar as with 10 Molar concentration of sodium hydroxide is used for preparing ferrocement specimen. The ferrocement specimen with cement mortar is the control specimen for this study. The prepared mortar is placed in ferrocement moulds up to 5mm and it is placed in vibrator for 5 min. Then the remaining mortar is placed in in the mould. The mortar is placed in vibrator, such that the mortar is packed well inside the mesh. Mould used to cast ferrocement element is shown in (Figure 2). Wire meshing in ferrocement element given in (Figure 3). (Figure 4) shown the specimen after casting with meshing.

Figure 2. Mould used for casting

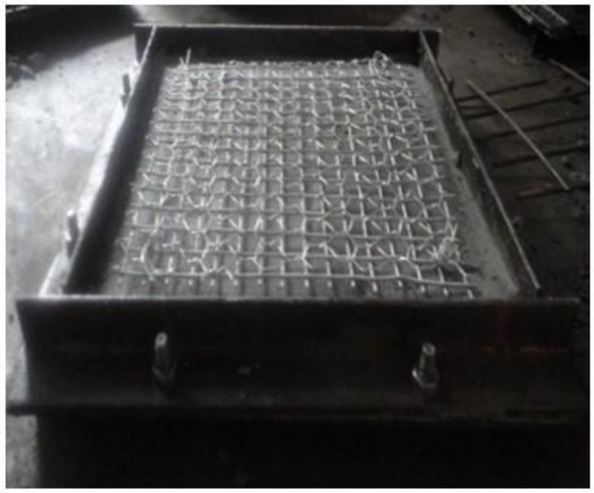

Figure 3. Mound with wire meshing

Figure 4. Casted specimen

Specimens were demoulded in one day and cured by conventional method of curing in water for 28 days. Heat Curing chamber shown in (Figure 5). The specimens were exposed to three different temperatures for 120 minutes to investigate thermal behaviour of geopolymer mortar or strength under high temperature. Fire exposure in furnace shown in (Figure 6).

Figure 5. Heat curing chamber

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Figure 6. Casted specimen

5.5 Flexurel test of ferrocement

The ferrocement specimens are tested for flexural strength in standard UTM as shown in (Figure 7). Thus, the span of the specimen is 180mm and the width of the support is 15mm on both the side. The Ferro-Geopolymer concrete and ferrocement specimens which are exposed and unexposed are subjected to flexure examination. Middle concentrated load for full width applied at the rate of 0.2kN/min.

Figure 7. Flexure test setup

5.6 Impact strength

The impact strength is nothing but the potential energy absorbed by the element when any weight dropped from a certain height. In free fall test, an Iron ball weighing 1.2 kg is allowed to fall from 0.4 m of height. The fall of the ball is guided by the hollow pipe throughout the falling height. Here the specimens are tested in impact testing apparatus as shown in the (Figure.10) as per ASTM D522. The iron ball weighing 1.2 kg is allowed to fall on the specimen guided by the PVC pipe from a height of 400mm.The ball is dropped from the certain height manually.

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The number of blows or fall is correlated to the impact strength of the specimen. Impact testing setup given in (Figure 8). The parameters, mass of the ball and height of fall are constant. Hence the number of fall changes for each specimen. Therefore, from the number of fall itself we can judge the impact strength of the specimen. Moreover, the loss in weight after the exposure of the specimens was found out. The weight of the specimen before and after is taken. And the residual weight is calculated.

***Fig*ure 8.** Flexure test setup

6. Results and discussion

6.1 Flexural strength

The Ferro-Geopolymer concrete and ferrocement specimens, which are exposed and unexposed are subjected to flexure test. The center point loading for full width was injected at 0.2 kN/min rate. The flexure test results are satisfactory for the ferro-geopolymer concrete after fire exposure. The elements which are exposed to various temperatures tested for flexure using UTM. Thus, the load vs Deflection graph for 300oC , 600oC and 900oC exposure is given in (Figure 9), (Figure 10) and (Figure 11) separately.

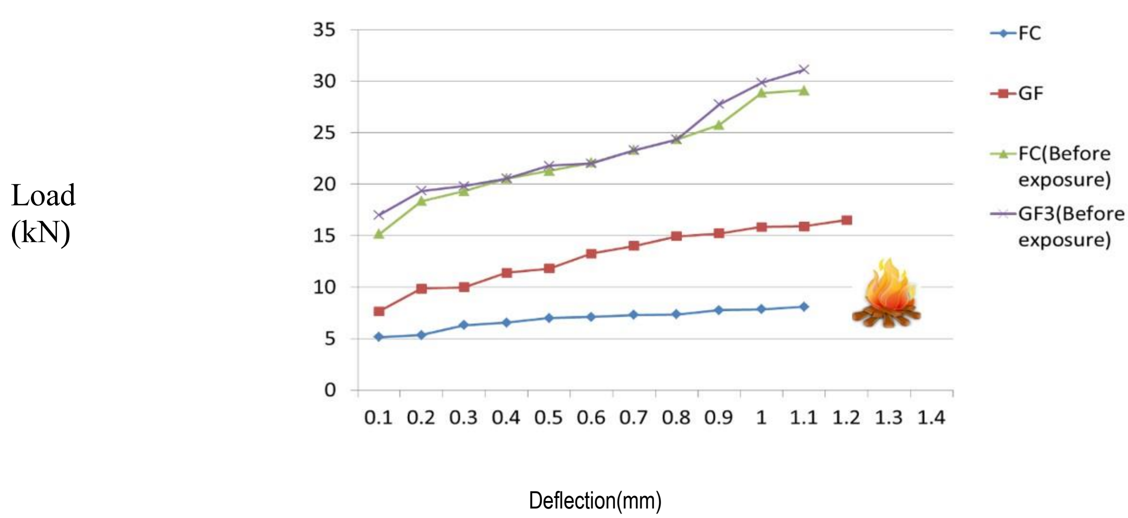

Figure 9. Load nVs deflection graph of specimen for 300°c exposure

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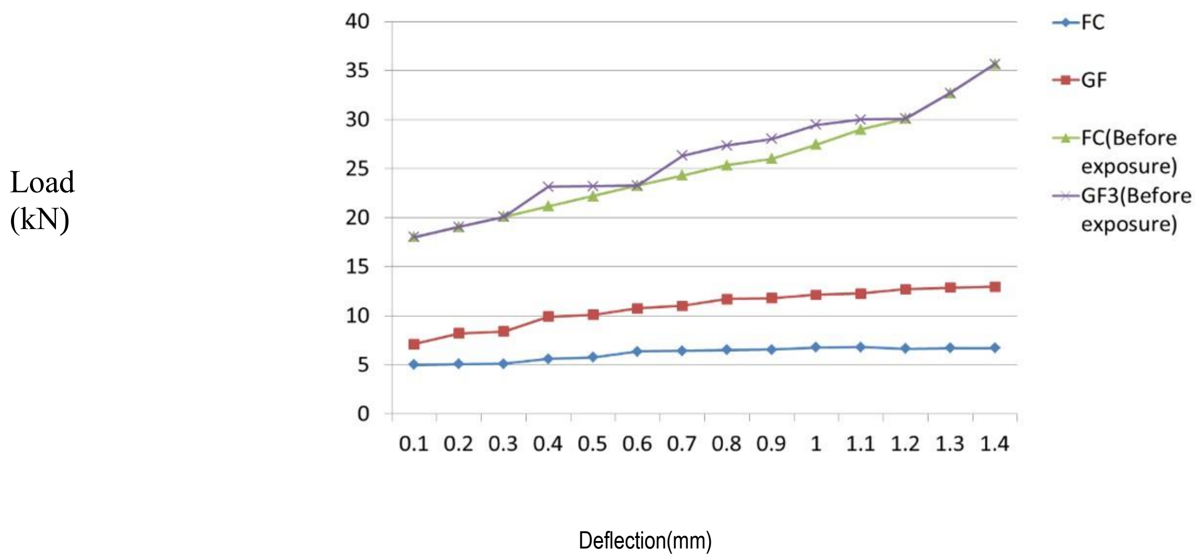

Figure 10. Load Vs deflection graph of specimen for 600°c exposure

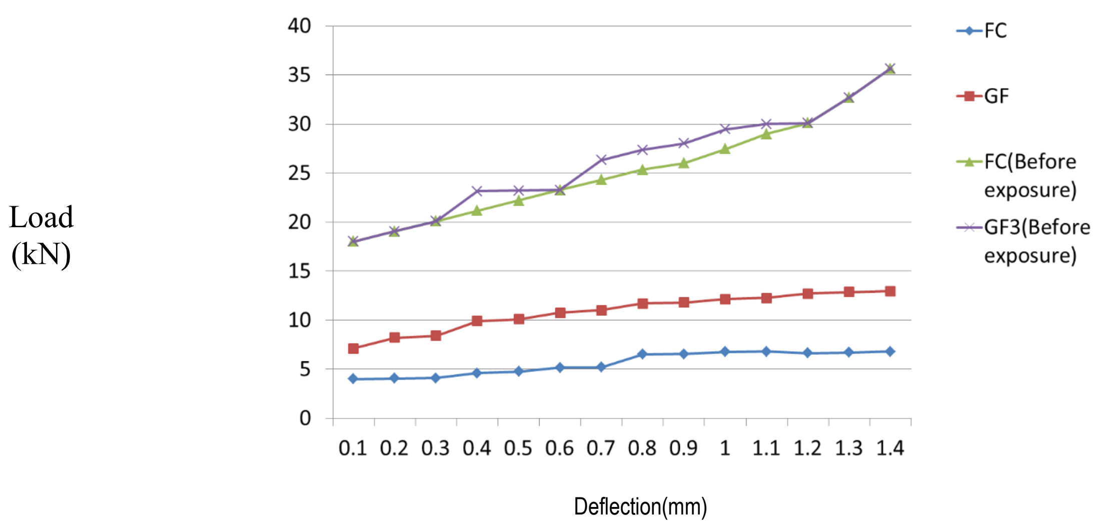

Figure11. Load Vs Deflection Graph of specimen for 900°c exposure

6.2 Impact of volume fraction on wire mesh

The effect of the volume fraction was investigated using a standardised mortar cover of 5 mm by adjusting wire net volume fraction from 2.1%, 1.8 %, and 1.5 %, which were equal to 2, 1 and 0 coatings of hexagonal wire mesh, correspondingly. Results of volume fraction consequence on relative flexural potency given in (Table 7).

Table 7. Effects of volume fractions on relative flexural strength

	FLEXURAL STRENGTH (MPa)					
Volume Fraction	2.1%		1.8%		1.5%	
Temperature	FC(Mpa)	FG(Mpa)	FC(Mpa)	FG(Mpa)	FC(Mpa)	FG(Mpa)
Before Exposure	22.2	22.8	12.27	13.18	11.24	11.98
300°C	19.8	21.72	6.82	7.62	5.82	6.2
600°C	15.54	20.28	3.64	4.28	3.24	4.18
900°C	6.9	17.4	2.94	3.41	1.9	2.62
Residual Strength	31.08	76.32	23.96	25.88	16.9	21.87

6.3 Impact strength

Impact strength is found out from the test set up as per ASTM D522.The number of blows or the potential energy absorbed by the specimen is correlated as impact strength. Thus, the results show that, as the volume fraction rises impact potential getting increased. Moreover, residual impact on Ferro-geopolymer concrete shows superior performance than the ferrocement. The main reason for the worst performance of ferrocement specimen after fire exposure is its formation of cracks and hence the bonding between the mesh and mortar is lost. Since the Ferro-Geopolymer concrete has less cracks and its residual impact strength is good. The result of impact Strength in given in (Table 8).

Table 8. Residual impact strength

Temperature	**Volume fraction**	Impact strength (Joules)					
		2.1%		1.8%		1.5%	
		FC	FG	FC	FG	FC	FG
Before Exposure		103.48	117.36	89.38	112.90	98.78	112.89
900°c		70.56	94.08	47.04	61.15	56.44	75.26
Residual strength (%)		68.18	80.16	52.62	54.16	57.14	66.67

6.4 Loss in weight

The ferrocement specimen underwent a notable weight loss after fire exposure. The residual weight of ferro-geopolymer concrete is not as notable as the normal ferrocement. Since the ferro-geopolymer concrete is already a less weight member due to the usage of fly ash, the loss in weight is not a considerable one. The fly ash is already a burnt material or residue. Thus, the burning of fly ash does not show any particle size variation. The loss in weight is compared and illustrated in this tabulation. Loss of weight after exposure to fire given in (Table 9).

Table 9. *Loss of weight after fire exposure*

Temperature	**Volume fraction**	Weight (Kg)					
		2.1%		1.8%		1.5%	
		FC	FG	FC	FG	FC	FG
Before Exposure		3.281	2.978	3.19	2.68	3.381	2.778
900°c		2.910	2.920	2.89	2.520	3.10	2.60
Loss in Weight		0.371	0.058	0.30	0.160	0.281	0.178

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6.5 Colour change

As opposed to the colour shift of ferro geopolymer concrete, the colour of the FC surface next to heat exposure stood observed brighter comparing without fire. major reason for colour change geopolymer specimen is the presence of sodium ion compounds in the geopolymer mortar. Colour change after fire exposure at 9000 C for Ferrocement element and Ferro geopolymer element shown in (Figure 12) and (Figure 13) respectively.

Figure 12. Colour change of ferrocement

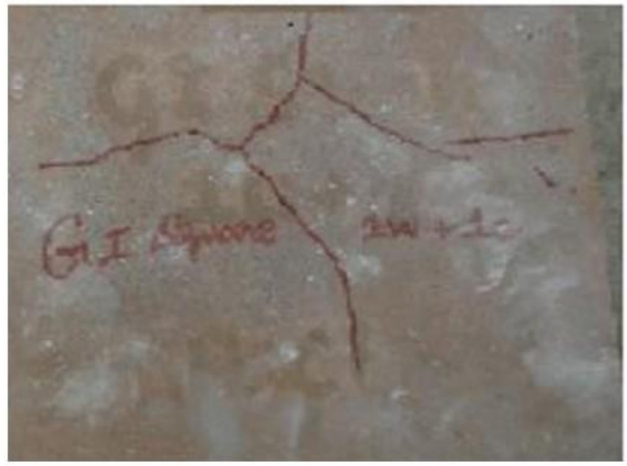

Figure 13. Colour change of ferro geopolymer element

6.6 Crack pattern

The skeletal steel induced cracks are formed in the specimen having volume fraction of 2.1% where only welded mesh used. In the ferrocement specimen the double in-plane cracks are predominant where the Ferro-Geopolymer concrete had no such cracks. These cracks are the major reason for the failure and disintegration of specimen. The types of cracks formed in this investigation are illustrated here in (Figure 12) and (Figure 13).

6.6 Spalling

The ferrocement specimens are always better in terms of spalling when compared to RCC components. ferrocement samples showing to raised temperature, it induces major cracks in ferrocement specimen when compared to ferro-geopolymer concrete. The spalling of both the specimens is illustrated in (Figure 14) (ferrocement) and (Figure 15) (ferro geopolymer).

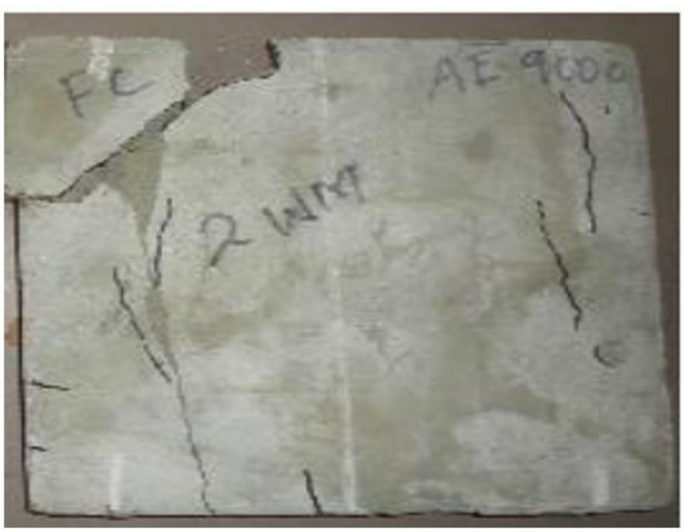

Figure 14. Colour change of ferrocement

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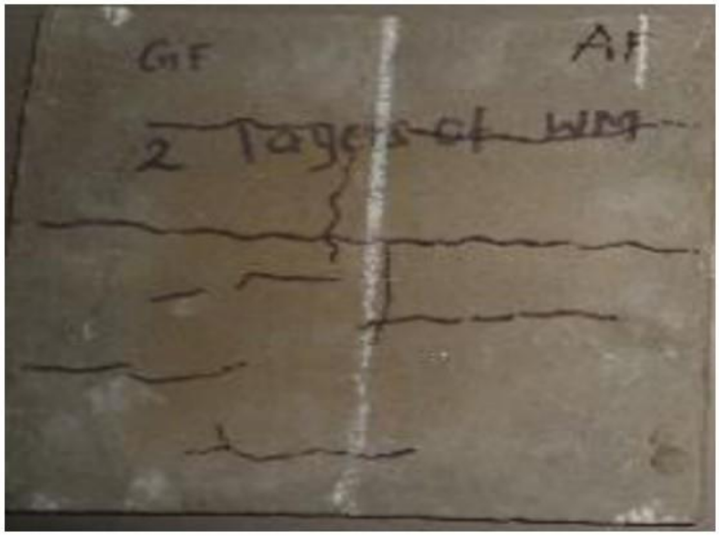

Figure 15. Colour change of ferro geopolymer element

5. Discussion

From the experimental results we found that after fire exposure residual compressive strength of G2 mix (56.01 Mpa) was high comparing M1 (47.02 Mpa), G1(44.01 Mpa), G3(24.01 Mpa) and G4 (44.01 Mpa) mixes. Also, its noted that loss of weight be less in ferro geopolymer specimen with volume fraction 1.8 % comparing Ferrocement and ferro geopolymer element having 2.1 % and 1.5 % volume fraction. Before fire exposure Flexural Strength of ferro geopolymer concrete specimen with volume fraction 2.1 % was found high 22.8 Mpa comparing all other mix with different volume fraction. Also, when specimen subjected to 300oC, 600 oC and 900 oC the same 2.1 % Volume fraction gives maximum flexural Strength 21.72 Mpa, 20.28 Mpa and 17.4 Mpa respectively comparing other mixes. The residual Strength of FG with 2.1 % volume fraction was found high (76.32 Mpa) and it was 40.72 %, 31.39 %,33.90 %, 22.14 % and 28.65 % more comparing FC with 2.1 % volume fraction, FC with 1.8 % volume fraction, FG with 1.8 % volume fraction, FC with 1.5 % volume fraction and FG with 11.5 % volume fraction respectively. Before and after fire exposure at 900 o C the impact strength of FG with 2.1 % volume strength was high (117.36 joule and 94.08 Joule). Residual impact Strength of ferro geopolymer concrete with 2.1 % volume fraction was found high 80.16 % comparing FC with 2.1 % Volume fraction (68.18 %), FC with 1.8 % volume fraction (52.62 %), FG with 1.8 % volume fraction (54.16%), FC with 1.5 % volume fraction (57.14%) and FG with 1.5 % volume fraction (66.67%). From the visual observation we found that spalling of ferrocement specimen induces more crack comparing spalling of ferro geopolymer element. Ferrocement specimen colour turned lighter after exposed to 900 oC and due to presence of sodium iron the colour of ferro geopolymer turned brown. From above discussion we finally found that the Ferro blended geopolymer have greater fire resisting capacity with volume fraction 2.1 %.

6. Conclusion

In this investigation the geopolymer mortar which is superior than the normal cement mortar in thermal properties is used to prepare the ferrocement element. Thus, the ferro geopolymer mortar (Ferrocement made with geopolymer mortar) is exposed in fire up to 900°C is tested for flexure and impact and it is compared with the normal ferrocement. From this study the following conclusions are made. They are,

- *The influence of molar concentration of Sodium Hydroxide is studied elaborately, where the geopolymer mortar made with 10M concentration of NaOH shows better performance in fire resistance. The compressive strength after fire exposure of 8M, 10M, 12M and 14M geopolymer mortar are 40.18 MPa, 53.23 MPa, 43.42 MPa and 38.86 Mpa respectively. As a result, the activator concentration has a significant impact on both the original and residual power after heating.*
- *Traditional Portland cement mortar is less resistant to high temperatures than geopolymer mortar. ferro-Geopolymer concrete was identified alternative to fire safety as opposed ferrocement because of flexural resilience after exposed to fire*
- *Ferro-geopolymer concrete has nearly 59.2 % more residual strength than that of the normal ferrocement. As the temperature increases, the flexural strength is getting decreased. volume fraction of ferro-geopolymer concrete 2.1%, 1.8% and 1.5 %, the residual flexural strength is decreased as 31.08 Mpa, 23.96 Mpa and 16.9 Mpa respectively. So, it shows that volume fraction has influence in flexural Strength.*

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- *Ferro-geopolymer concrete has nearly 14.92 % more residual impact strength than that of the conventional ferrocement made with cement mortar. As the volume fraction increases the residual impact strength getting increased. Thus, as the volume fraction of mesh decreases as 2.1%, 1.8% and 1.5 %, the impact strength of the ferro-geopolymer concrete decreases as 68.18 Joules, 52.62 Joules and 66.67 Joules respectively.*
- *In terms of colour change, the conventional ferrocement element retains its appearance even after fire exposure. But the Ferro-geopolymer concrete changes its dark grey colour in to brown colour after fire exposure.*
- *The loss in weight after fire exposure is a main parameter to find the fire resisting character. Since the Ferro-Geopolymer concrete is made of already burnt fly ash, the fire exposure didn't make any notable change in the weight loss. But the ferrocement shows a considerable decrease in weight after fire exposure. The ferrocement shows a maximum weight loss of 0.37 Kgs after fire exposure, while the weight of ferro geopolymer concrete decreases nearly just 20 to 30 grams after fire exposure.*

7. References

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