



Design, Modelling and Fabrication of Advanced Robots

Vol: 1(2), 2022

REST Publisher; ISBN: 978-81-948459-3-5

Website: <http://restpublisher.com/book-series/dmfar/>

Evaluation of Fire-Retardant Glass Fibre using the SPSS Method

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Abstract. Fiberglass is spanned into glass fibers and Fiberglass insulation is intrinsically fire-resistant and is then mixed with plastic polymers. Although fiberglass won't produce, you should exercise caution when using paper- or foil-backed pads because they can burn very quickly. Compared to conventional non-flammable materials, FRP is combustion and presents a number of difficulties. Fire safety precautions and safety barriers are critical. Glass fiber is an inorganic substance with excellent mechanical strength, superior thermal insulation, and strong heat resistance. Glazed wired glassware and ceramic glass are the two main categories of fire-rated glass. Glazed wire glass, the earliest glass fire solution currently accessible, is produced with strands of wire or wire mesh inserted inside the material during manufacturing. Fabrics like wool and Kevlar will resist flames longer than cotton or linen because of how their fibers are naturally structured. These are the best textiles to protect your home from fire. Materials such as Nomex, Kevlar, and Modacrylic are frequently used to construct parts of FR clothing because they have good flame-retardant properties. Other fabrics, like cotton, have built-in flame resistance and can be chemically treated to boost their barrier properties and defensive capabilities. Glass fiber Composites containing fiber reinforcement are used in the construction sector because of their high specific flexibility and strength properties, high damping, superior corrosion resistance, as well as low thermal expansion (cold station construction), in aeroplanes, and in land and sea vehicles, among other applications. Unfortunately, epoxy poses a risk to life and property due to its flammability and considerable gas and fume emissions. Reducing their fire hazards is usually accomplished by adding A protective FR coating from around composite improves the fire resistance of the manufactured parts by adding a fire retardant (Br) to the polymer matrix. Composite and responsive FR are the two forms of FR that have so far been incorporated within composite systems. The research done over the past 10 years to increase the fire excellent resistance of glass fibre reinforcement epoxy composites by integrating both varieties of FRs is the main subject of this review. This article also provides an overview of the geopolymer research that has been done to improve the heavy armour of epoxy-based materials. The possibility for improving the fire resistance qualities of fibre reinforcement epoxy by using geopolymer as one of the FRs composites is also presented in this paper, opening up some options for further research. Ratio studies are statistical analyses of data from appraisals and property valuations. Nearly all states utilise them to produce quantitative measure of the proportion of current market price about which individually estimated taxable property is appraised as well as to offer assessment performance indicators. Heat release rate, Peak heat release rate (PHRR), Fire growth rate (FIGRA), Total heat release and Time-to-ignition (TTI). The Cronbach's Alpha Reliability result. The overall Cronbach's Alpha value for the model is .658 which indicates 66% reliability. From the literature review, the above 50% Cronbach's Alpha value model can be considered for analysis. Characteristics of sisal fiber the Cronbach's Alpha Reliability result. The overall Cronbach's Alpha value for the model is .658 which indicates 66% reliability. From the literature review, the above 50% Cronbach's Alpha value model can be considered for analysis.

Keywords: Heat release rate, Peak heat release rate (PHRR), Fire growth rate (FIGRA), Total heat release and Time-to-ignition (TTI).

1. Introduction

Low toxicity and flame retardant by grafting the abovementioned compounds out on to the membrane of GO, it is expected to produce a flame retardant that is both environmentally friendly and highly effective. Graphene oxide is added to make a flame retardant, but this process can cause the flame retardant to collect in the structure, which will obviously affect the mechanical qualities. In contrast, the interactions between molecular chains of macro molecularly modified graphene oxide create a mechanical complex with the matrix and result in high-performance flame-retardant properties as well as load transfer. to preserve reliable mechanical characteristics [1]. Polyolefin 14 has good flame resistance. Higher flame-resistant levels have drawbacks besides the increase in component density, including production challenges and loss of mechanical qualities. As a result, Al(OH)₃ has frequently been employed in experiments alongside other flame retardants such fullerene, Nano clay, zinc borate, dimethyl methyl phosphonate, ammonium polyphosphate, etc.

Ethylene-vinyl acetate is very flammable, and Guo et al. found that adding 40 weight percent of aluminium hydroxide (Al(OH)₃) significantly increased its LOI values from 19.5 to 26 [2]. Thermal protection period was observed to be longer for intumescent fire retardant treatments and polycarbonate sheets containing 4.5% nano-TiO₂. A material with an as double nano-layered structure called layered doubling hydroxide (LDH) primarily consists comprises a positive electrode anion and a positive metal charge depletion zone. Typically, a metal oxide layer consisting of magnesium oxide and zinc oxide makes up naturally occurring LDH aluminium oxide, with carbonate ions making up the majority of the intermediate anions [3]. The following section contains several dosages of foundational phosphate (DPP-CFR) that were used to increase the strength properties of the final ECFGE/DDM item. To determine the effect of DPP-CFR also on the sintering of the ECFGE/DDM system, the non-isothermal curing behaviours of unbleached ECFGE/DDM and ECFGE/DDM-3 platforms were explored [4]. Then, using a cone calorimeter and charcoal to provide the ideal ratio, the characteristics of fire in regular EP, EP/15%APP, & EP/15%APP/Cu₂O were investigated. Finally, a practical operating strategy is suggested for this successful IFR system on the basis of a thorough analogical study [5]. Fire retardants Halogenated to enhance the popularity of polymer materials. However, a few fire retardants, consisting of polybrominated biphenyl ethers (PBDEs) and polybrominated biphenyls (PBB), launch sizable amounts of poisonous and corrosive gases for the duration of combustion, which continuously create environmental mental and environmental pollution and purpose bioaccumulation [6]. Glass fibre reinforced epoxy composites exhibit many blessings in engineering fields which includes buildings (bloodless save creation), plane, land and water motors, chemical agencies, defence, clinical packages, biomechanics, home equipment, among others in the listing of fibre reinforced polymer (FRP) composites. Sports, robots and machines due to fantastic houses inclusive of high-particular stiffness and electricity, enlargement [7]. For structural metal packages Reinforced epoxy coatings take a look at (SST) and restricting oxygen index (LOI) checks had been performed usual overall performance to demonstrate the results of hybrid nanofillers of nanofillers with matrix Dispersion is classified with the resource Three, the other single studied and corrosion compared to hybrid nanofiller coatings showed further improvement in resistance All filled with nanofillers epoxy coating samples are also LOI Slow burn in test confirmed behavior [8]. Epoxy (EP) resin is widely utilized in intimate bonding of additives associated with human lifestyles its wonderful itching resistance, insulation and Due to the engine Residences. Also, EP is extensively used in corrosion resistant coatings for metallic structures. Also, a few massive oil tanks and marine oil The floors are corrosion resistant and to be covered with fireproof coating Functionality based on epoxy resin Wide application of coating materials have opportunities. However, epoxy coating substances [9] may additionally emit huge amounts of warmth, smoke, carbon monoxide, and different poisonous gases while burned. They have an effect on of filler structure and particle geometry (range grapheme blends are mentioned. epoxy compounds and graphene with different fillers combinations of materials stable graphene a for epoxy compounds offered as a promising prospect [10]. Awareness of the houses of natural fiber-based totally epoxy composites to satisfy engineering desires have elevated. Fiber, with map values of 12.5 and eleven.9, respectively, as its power extended with progressed interfacial adhesion. In addition, abaca exhibited high electricity whilst absorbing moisture [11]. Phosphorus-Based Epoxy Gel coat Formulations We organized epoxy resin-based totally gel coats with five %, fabric the usage of the in tumescent flame retardant (FR) Ammonium Polyphosphate (APP) and their heat equilibrium, mirror change determine the temperature we in comparison the cross linking reaction enthalpy and hearth efficiency with non-fire. Note we have included compounds [12]. Epoxy resins (EP) are used international in adhesives, electronic additives, and aerospace industries. Surface coatings, composite matrices, castings, and oven have the capacity, which is theirs, over-generalized overall Controls performance. programs due to protection concerns. Hence, of epoxy resins hearth retardancy Improvement is essential [13]. Fire retardancy of epoxy coatings with the aid of using incorporation of multiwall carbon annotates (MWCNTs). The consequences showed that Substrate 0.fivewt% MWCNTs /coated with epoxy coatings reduced the lowest temperature by using ninety C and improved the residue by means of Compared to pure epoxy coating Burned for 60 minutes Then 2.87%.14 U and Many people. Flame retardants organized through way of fictionalization of grapheme containing nitrogen and phosphorus.1 [14]. Excess phosphorus and nitrogen to its mineral backbone with content fireproof and self-extinguishing the ingredients are not simple, however additionally its for excessive heat balance. However coupling of LBP nanofillers has not regularly been tried. With their correct flame resistance and comparatively reactive phosphorus-chlorine bonds, LPPs Linear Polyphosphate (LPP) / Flame MoSe₂ hybrids encourage reading for prevention programs [15]. This study first brought 4 Floor pre-treatment processes to pre-regulate BF, then BF modified by using way of γ -aminopropyltrioxysilane (KH550) Bisalt Piper BolsteretIn EP to prepare epoxy compounds Second, an progressed pre-treatment technique and BF modified with the aid of KH550 were delivered to the Basalt fiber named EP/AP750/BF-AT Flame for preparing reinforced EP/AP750 Retardant epoxy (EP/AP750). Then, of those compounds Mechanical, thermal and stove houses are systematically inspected were made. The most important finding of this study is that surface treatment of basalt fibre and basalt fiber-primarily based epoxy mechanics of composites Purification of relationship between houses [16]. Fire of hyperbranched phosphorus and nitrogen compounds prevention.38 is top notch LOI results in charge and V-crossing the zero level indicated. P/N synergistic in flame retardancy in addition to effect, In addition to the system of mutual trade expresses. Improves oven safety for maximum flame retardant modified EP Transparency of the material Has flame retardancy at cost [17]. Epoxy resin is a fireplace danger that is in the main meditated in the following factors. One, this is through the epoxy resin combustion test reduces PHRR and THR, charcoal after combustion and LOI Increases residual volume price. On the other hand, grapheme in smoke suppression

strain performance there is a certain incentive effect this is at the discount of TSP reflects well [18]. Epoxy matrix. Moreover, gap became observed on interface of APP debris and epoxy matrix, Not for ZIF-67 now. With APP/EP The balance of ZIF-67 compared to ZIF-sixty Step forward by seven@APP/EP to be important for mechanical housing It turned out to be a must on the one hand, the anchor of ZIF-sixties seven may want to growth the precise surface place as a result of APP, ZIF-67@APP and the contact area between the matrix is enlarged in addition, organic in the form of ZIF-67 2-methylimidazole structure In curing epoxy resins has a catalytic function [19]. The examiner 20, 35, 50, and seventy-five kW/m² radiant heat of ATH and APP in temperature fluxes Jute with distinct weight sections Ignition and burning of epoxy compounds studied behavior Meaning grows to be additionally tested for thermal homes the usage of the transient aircraft supply technique. In addition to discussing the experimental effects, the evaluation turned into studied in precise or apparent parameters, of 2 retardants with amazing weight fractions study to identify compounds do it. An analysis of the results was determined subsequent [20].

2. Material and Method

Heat release rate: Heat release rate (HRR) of fire is the rate of heat generation This is usually joules per second or measured in watts, because of fire The output will produce more than one watt. For ease of measurement, MW or kilowatt is used. Heat output the quantity of energy released each unit time from the burning of the fuel is measured in rate and has units of calories (or kW, MW, etc.). Heat is energy that is transmitted from one environment to another due to the two systems' varying temperatures in a thermodynamic sense. An exothermic process produces heat, which raises the temperature of the immediate environment. An exothermic reaction process that removes energy cools the environment.

Peak heat release rate (PHRR): Peak HRR is during combustion Maximum heat process Defines output rate. Decomposition process Peak HRR occurs when it occurs maximum flammability of a substance Reliable in character and flashover capability considered as measurement The maximum rate at which heat is produced during combustion is known as maximum HRR Peak HRR is recognised as an accurate reflection of a structure's highest flammability as well as flashover potential and comes when the breaking process progresses at its fastest rate. The rate at which a wildfire releases energy, also known as power, is known as the heat release rate (HRR). The European System of Units unit of measurement for HRR is Watts (W), or one joule for every second. Use the formula $Q = mcT$, in which Q is the amount of heat energy communicated (in joules), m is the quantity of the heated fluid (in kilogrammes), where c is the temperature unique mass, to figure out how much of heat generated in a chemical reaction. where T is the change in the fluid's heat capacity (measured in joules per kilogramme degree Celsius).

Fire growth rate (FIGRA): The rate of Fire development is the process of ignition and flame propagation depends on, defines its perimeter and after igniting a combustible surface the fire spreads or in the room Additional ingredients are added. The method of ignition, the spread of the flames that define the perimeter of the fire, and the mass igniting flux in the affected region all affect how quickly the fire spreads. When a combustible surface catches fire, the size of the fire grows as the flame travels across the material or as more materials enter the space.

Total heat release: Total Heat output (THR) THR is the combustion of the cell is a measure of the heat energy generated during It is energy or surface area expressed in terms of normalized energy, For example, kWh m⁻². It's hot under publication rates Integrated-burning time plot

Time-to-ignition (TTI): Fire development is the process of ignition and flame propagation depends on, defines its perimeter and after igniting a combustible surface, fire spreads or in the room additional ingredients are added. Time-to-ignition (dyke) is a exposed to a heat source How quickly when combustion occurs defines that at a given incident heat flux and in an oxygen-restricted environment.

Method: SPSS Statistics is a statistical control Advanced Analytics, Multivariate Analytics, Business enterprise Intelligence and IBM a statistic created by a software program is a package crook research. A set of generated statistics is Crook Research is for a long time SPSS Inc. Produced by, it was acquired by IBM in 2009. Current versions (after 2015) icon Named: IBM SPSS Statistics. The name of the software program is to start with social Became the Statistical Package for Science (SPSS) [3] Reflects the real marketplace, then information SPSS is converted into product and service solutions Widely used for statistical evaluation within the social sciences is an application used. pasted into a syntax statement. Programs are interactive Directed or unsupervised production Through the workflow facility. SPSS Statistics is an internal log Organization, types of information, information processing and on applicable documents imposes regulations, these jointly programming make it easier. SPSS datasets are two-dimensional Have a tabular structure, in which Queues usually form Events (with individuals or families) and Columns (age, gender or family income with) to form measurements. of records Only categories are described: Miscellaneous and Text content (or "string"). All statistics Processing is also sequential through the statement (dataset) going on Files are one-to-one and one-to-one Many can be matched, although many are not In addition to those case-variables form and By processing, there may be a separate matrix session, There you have matrix and linear algebra on matrices using functions Information may be processed.

3. Result and Discussion

TABLE 1. Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Heat release rate	90	4	1	5	282	3.13	.115	1.093
Peak heat release rate (PHRR)	90	4	1	5	270	3.00	.131	1.245
Fire growth rate (FIGRA)	90	4	1	5	291	3.23	.133	1.264
Total heat release	90	4	1	5	294	3.27	.119	1.130
Time-to-ignition (TTI)	90	4	1	5	297	3.30	.158	1.495
Valid N (listwise)	90							

Table 1 shows the descriptive statistics values for analysis N, range, minimum, maximum, mean, standard deviation Heat release rate, Peak heat release rate (PHRR), Fire growth rate (FIGRA), Total heat release and Time-to-ignition (TTI) this also using.

TABLE 2. Frequencies Statistics

		Heat release rate	Peak heat release rate (PHRR)	Fire growth rate (FIGRA)	Total heat release	Time-to-ignition (TTI)
N	Valid	90	90	90	90	90
	Missing	0	0	0	0	0
Mean		3.13	3.00	3.23	3.27	3.30
Std. Error of Mean		.115	.131	.133	.119	.158
Median		3.00	3.00	3.00	3.00	3.00
Mode		3	3	3	3	5
Std. Deviation		1.093	1.245	1.264	1.130	1.495
Variance		1.196	1.551	1.597	1.276	2.235
Skewness		-.429	.321	-.043	-.260	-.098
Std. Error of Skewness		.254	.254	.254	.254	.254
Kurtosis		.047	-.794	-.900	-.198	-1.484
Std. Error of Kurtosis		.503	.503	.503	.503	.503
Range		4	4	4	4	4
Minimum		1	1	1	1	1
Maximum		5	5	5	5	5
Sum		282	270	291	294	297
Percentiles	25	3.00	2.00	2.00	3.00	2.00
	50	3.00	3.00	3.00	3.00	3.00
	75	4.00	4.00	4.00	4.00	5.00

Table 2 Show the Frequency Statistics in Fire Retardant glass fibre. Heat release rate, Peak heat release rate (PHRR), Fire growth rate (FIGRA), Total heat release and Time-to-ignition (TTI) curve values are given.

TABLE 3. Reliability Statistics

Cronbach's Alpha Based on Standardized Items	N of Items
.658	5

Table 3 shows the Cronbach's Alpha Reliability result. The overall Cronbach's Alpha value for the model is .658 which indicates 66% reliability. From the literature review, the above 50% Cronbach's Alpha value model can be considered for analysis.

TABLE 4. Reliability Statistic individual

	Cronbach's Alpha if Item Deleted
Heat release rate	.587
Peak heat release rate (PHRR)	.656
Fire growth rate (FIGRA)	.536
Total heat release	.591
Time-to-ignition (TTI)	.614

Table 4 Shows the Reliability Statistic individual parameter Cronbach's Alpha Reliability results. The Cronbach's Alpha value for Heat release rate .587, Peak heat release rate (PHRR).656, Fire growth rate (FIGRA).536, Total heat release.591 and Time-to-ignition (TTI).614this indicates all the parameter can be considered for analysis.

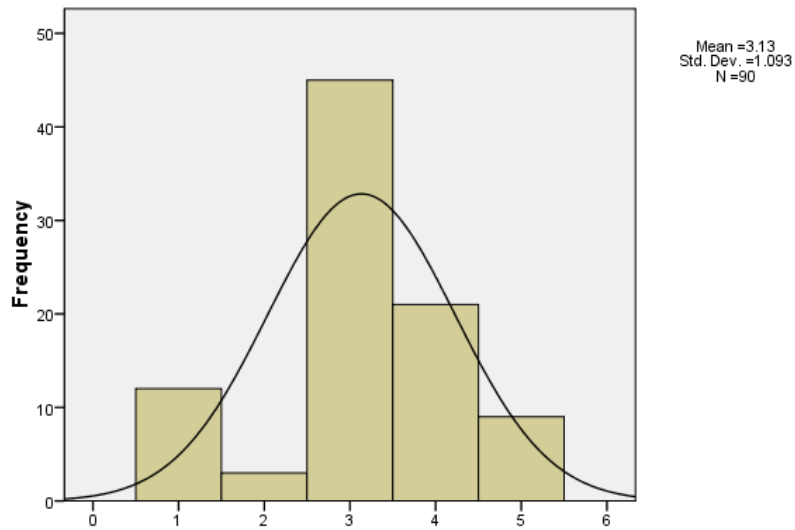


FIGURE 1. Heat release rate

Figure 1 shows the histogram plot for Heat release rate from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 3 for Heat release rate except the 2 value all other values are under the normal curve shows model is significantly following normal distribution.

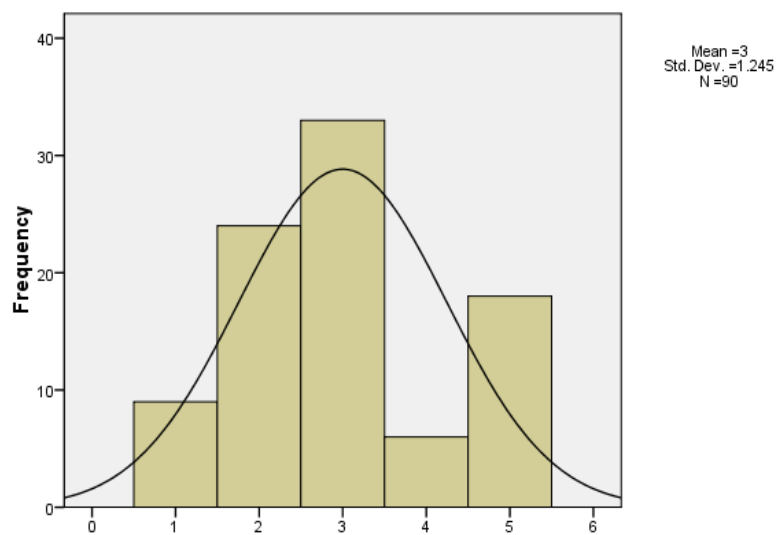


FIGURE 2. Water content (%)

Figure 2 shows the histogram plot for Water content (%) from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 3 for Water content (%) except the 2 value all other values are under the normal curve shows model is significantly following normal distribution.

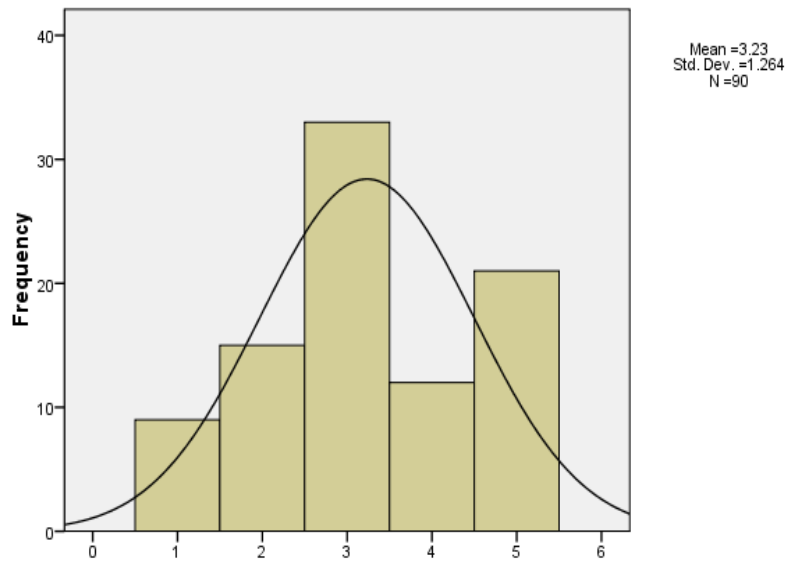


FIGURE 3. Fire growth rate (FIGRA)

Figure 3 shows the histogram plot for Fire growth rate (FIGRA) from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 3 for Fire growth rate (FIGRA) except the 3 value all other values are under the normal curve shows model is significantly following normal distribution.

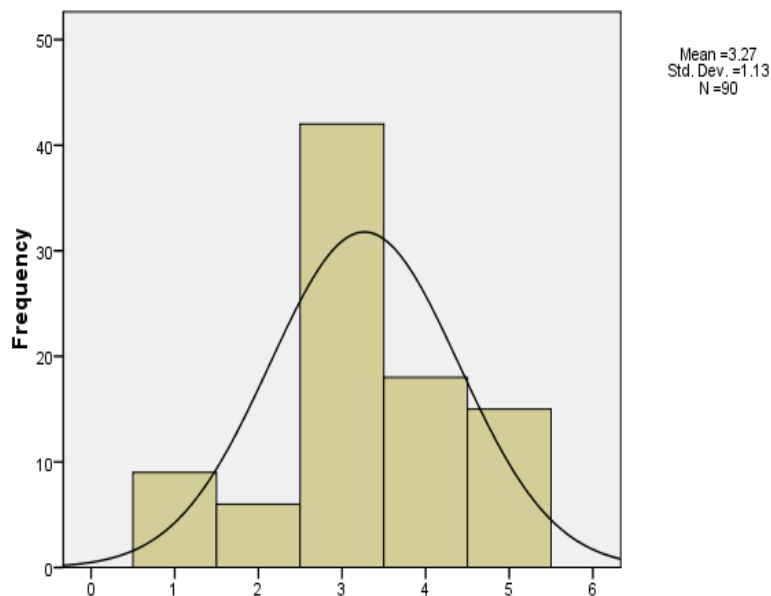


FIGURE 4. Total heat release

Figure 4 shows the histogram plot for Total heat release from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 3 for Total heat release except the 2 value all other values are under the normal curve shows model is significantly following normal distribution.

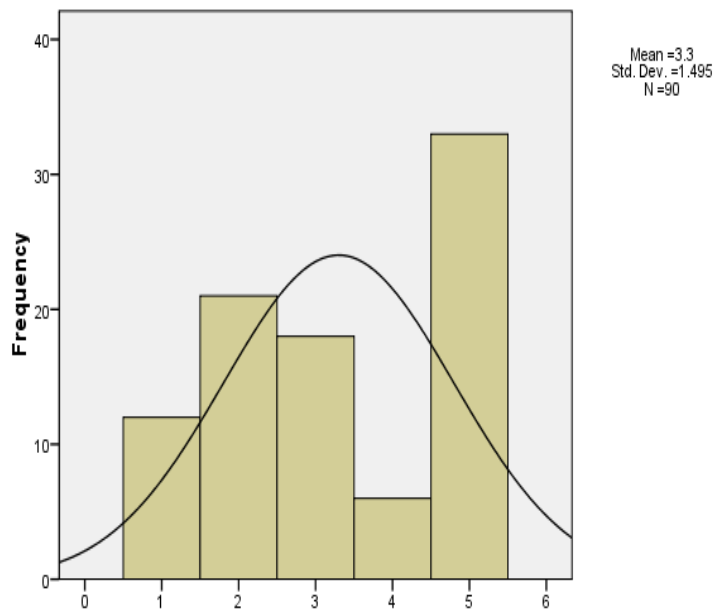


FIGURE 5. Time-to-ignition (TTI)

Figure 5 shows the histogram plot for Time-to-ignition (TTI) from the figure it is clearly seen that the data are slightly Right skewed due to more respondent chosen 5 for Time-to-ignition (TTI) except the 2 value all other values are under the normal curve shows model is significantly following normal distribution.

TABLE 5. Correlations

	Heat release rate	Peak heat release rate (PHRR)	Fire growth rate (FIGRA)	Total heat release	Time-to-ignition (TTI)
Heat release rate	1	.149	.368**	.407**	.264*
Peak heat release rate (PHRR)	.149	1	.214*	.096	.290**
Fire growth rate (FIGRA)	.368**	.214*	1	.499**	.319**
Total heat release	.407**	.096	.499**	1	.172
Time-to-ignition (TTI)	.264*	.290**	.319**	.172	1
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

Table 5 shows the correlation between motivation parameters for Heat release rate. For Total heat release is having highest correlation with Peak heat release rate (PHRR) and having lowest correlation. Next the correlation between motivation parameters for Peak heat release rate (PHRR). For Time-to-ignition (TTI) is having highest correlation with Heat release rate and having lowest correlation. Next the correlation between motivation parameters for Fire growth rate (FIGRA). For Total heat release is having highest correlation with Peak heat release rate (PHRR) and having lowest correlation. Next the correlation between motivation parameters for Total heat release. For Fire growth rate (FIGRA) is having highest correlation with Peak heat release rate (PHRR) and having lowest correlation. Next the correlation between motivation parameters for Time-to-ignition (TTI). For Fire growth rate (FIGRA) is having highest correlation with Total heat release and having lowest correlation.

4. Conclusion

Fiberglass is spanned into glass fibers and Fiberglass insulation is intrinsically fire-resistant and is then mixed with plastic polymers. Although fiberglass won't produce, you should exercise caution when using paper- or foil-backed pads because they can burn very quickly. Compared to conventional non-flammable materials, FRP is combustion and presents a number of difficulties. Fire safety precautions and safety barriers are critical. Glass fiber is an inorganic substance with excellent mechanical strength, superior thermal insulation, and strong heat resistance. Glazed wired glassware and ceramic glass are the two main categories of fire-rated glass Glassfiber Composites containing fiber reinforcement are used in the construction sector because of their high specific flexibility and

strength properties, high damping, superior corrosion resistance, as well as low thermal expansion (cold station construction), in airplanes, and in land and sea vehicles, among other applications. Unfortunately, epoxy poses a risk to life and property due to its flammability and considerable gas and fume emissions. low toxicity and flame retardant by grafting the abovementioned compounds out on to the membrane of GO, it is expected to produce a flame retardant that is both environmentally friendly and highly effective. Graphene oxide is added to make a flame retardant, but this process can cause the flame retardant to collect in the structure, which will obviously affect the mechanical qualities. This is usually joules per second or measured in watts, because of fire The output will produce more than one watt. For ease of measurement, MW or kilowatt is used. Heat output The quantity of energy released each unit time from the burning of the fuel is measured in rate and has units of calories (or kW, MW, etc.). Decomposition process Peak HRR occurs when it occurs maximum flammability of a substance Reliable in character and flashover capability considered as measurement The maximum rate at which heat is produced during combustion is known as maximum HRR Peak HRR is recognised as an accurate reflection of a structure's highest flammability as well as flashover potential and comes when the breaking process progresses at its fastest rate. The rate of Fire development is the process of ignition and flame propagation depends on, defines its perimeter and after igniting a combustible surface the fire spreads or in the room Additional ingredients are added. Total Heat output (THR) THR is the combustion of the cell is a measure of the heat energy generated during It is energy or surface area expressed in terms of normalized energy, For example, kWh m⁻². It's hot under publication rates Integrated-burning time plot Fire development is the process of ignition and flame propagation depends on, defines its perimeter and after igniting a combustible surface, fire spreads or in the room additional ingredients are added. Ratio studies are statistical analyses of data from appraisals and property valuations. Nearly all states utilise them to produce quantitative measure of the proportion of current market price about which individually estimated taxable property is appraised as well as to offer assessment performance indicators. Heat release rate, Peak heat release rate (PHRR), Fire growth rate (FIGRA), Total heat release and Time-to-ignition (TTI).The Cronbach's Alpha Reliability result. The overall Cronbach's Alpha value for the model is .658 which indicates 66% reliability. From the literature review, the above 50% Cronbach's Alpha value model can be considered for analysis

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