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### RESEARCH ARTICLE

#### EVALUATION OF CEMENT POLYMER COMPOSITES USING SPSS ANALYSIS

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#### Abstract

Cement Polymer Mixtures are made of Cement, sand, or bulk polymers are made using polymers added to improve their compressive strength, fatigue resistance, impact, and durability. Hydraulic cement polymer composites, created with modern polymer technology, are well-known for enhancing the development of composite materials and new products. This technology aims to improve both polymer cement for new construction and its use in repairing old cement. The adhesive properties of polymer cement allow for correction and bonding of both polymer-based and conventional cement. Cement-based composite materials, such as hardened cement paste, are formed by the combination of cement, water hydration, various minerals, metals, and polymeric materials. Different combinations of these materials can result in cement binders that are used for construction. Cement, a chemical substance used as a binder, sets and hardens to bind things together. It is rarely used alone and is typically combined with sand and gravel. Polymer cement is a type of cement-polymer composite where conventional cement hydrates are replaced by polymer binders or liquid resins. It is prepared by completely replacing the hydrate binders of cement with the polymer binders or liquid resins. This mixture forms a cement-polymer composite. Cement-polymer composites are durable materials that exhibit long service life and can withstand harsh environmental conditions. They are not affected by extreme temperatures, whether hot or cold, as dry concrete has a low coefficient of expansion and can accommodate moderate movements in the design. Evaluation parameters for cement include calcium oxide, magnesium oxide, silicon dioxide, aluminum oxide, sodium oxide, potassium oxide, and sulfur trioxide.

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#### Introduction:-

The development of cement polymer composites, with a cement-like composition, expands the range of applicability. The opportunity is open for polymer cementitious admixtures, which resist acids and chemicals such as salt solutions. Cement polymer composites have much higher resistance to coastal, coastal, and chemical industry environments compared to polymer-enriched fibrocement, a thin and lightweight mixture. They offer great potential for use in structures.

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Polymer-cement composites are cost-effective, highly durable, and require chemical resistance. However, materials and compounds used so far are expensive. In this situation, developing countries may use inefficient or expensive construction materials and mistake their employment for substitutes. Polymer cement and polymer compounds can be used in food processing, chemical industries, wear-resistant flooring, and steel bridges. Due to their early strength development, they are highly suitable for repairing marine defense structures. Modern construction materials engineering improves durability and creates objects with intended use, reducing the need for repairing cement structures. Furthermore, efforts are being made to develop repair materials and technological solutions that facilitate the process. Concepts such as self-healing materials and cement-polymer compounds are being explored for new products. While polymers are resistant to chemical agents, their resistance to microbiological factors varies. For instance, short-chain oligomers with a molecular weight less than 500, including polyolefins, can promote the growth of fungi. Microbiological degradation of polyesters occurs at a molecular weight limit of 60. In recent years, polyether-containing polyesters have been preferred over polyurethanes, as polyurethanes are highly susceptible to microbial degradation and easily affected. In the early 1900s, cement mixtures were used for manufacturing building materials. Cement used in oil and gas wells penetrates into the well underground to permanently isolate systems or fill the wells when abandoned.

### **Cement Polymer Composites:**

In wellbore scenarios, cement deterioration can lead to adhesion loss in the casing, which is unnecessary and may cause harmful leakage. Additionally, heavy repair costs can occur. In this work, the authors aim to bring about self-healing by exploring the use of polymers and a herring mixture in regular wellbore cement. They study the properties of polymer-cement admixtures and their interaction with the casing. The analysis proves the ability of these polymers to reduce self-healing through atomic simulations. The application of these polymers shows good surface wetting properties on steel, indicating their compatibility with steel and cement/polymer connections, resulting in a wide range of binding patterns [1]. In pressurized water reactors, the main component of the liquid waste generated is boric acid ( $H_3BO_4$ ). Boric acid wastes, mostly sodium, are neutralized using hydroxide and then concentrated through evaporation in a boric acid evaporator, producing approximately 50,000 gallons annually. As a result, borate emulsion is typically incorporated into cement, polymer, bitumen, or cement-polymer composites. The long-term solidification of radioactive waste forms is an important part of proactive radioactive waste management research, aiming to mitigate environmental impacts over time. Instead of simulated accelerated aging testing, observations of different nature are conducted to follow the actual aging of the waste form over many years under real-time conditions [2]. In reinforced cement (RC) structures, polymer-composites are widely used to delay the onset of corrosion by coating steel rebars with cement. However, the coating of cement-polymer composites (CPC) on rusted steel is sometimes underutilized, leading to premature expansive erosion. This article investigates the effect of insufficient application of CPC on the service life of RC structures, such as coating and premature corrosion. To this end, chloride concentrations, diffusion coefficients, and chloride limits derived from samples from a bridge that is several years old and prepared in the laboratory are determined through a one-year laboratory study [3]. The presence of a highly flexible polymer in cement allows for uniform distribution, as confirmed by experimental and density-functional calculations. This composite material brings about 60-70% higher tensile strength compared to cement alone, thus increasing flexibility. The considerably high tensile strength and high ductility of the composite material provide cement with ductility. Alongside its reported self-healing ability, this cement-polymer composite is critical in reducing the formation/propagation of fractures resulting from mechanical stress, particularly in geothermal wells. Its use can contribute to reducing well failures and related environmental and economic issues [4]. The latest developments in self-healing cement and epoxy polymer composites are stimulated by the exploration of the calcium-silicate hydrate/polymer interface using ab initio molecular dynamics and bulk spectroscopy frequency generation (SFG). On defect surfaces, polymer aggregation and hydrogen bonding interactions weakly adhere, making assembly towards defective surfaces easy. Furthermore, deprotonation of the polymer hydroxyl groups on the broken surfaces results in Ca-O ion bonding, strengthening the polymer. Moreover, polymer S-S groups away from the cement/polymer interface enable self-healing within the polymer. Overall, the elasticity and flexible healing properties of these composites are formed through the hydrogen bonding network, allowing for instant adjustment of the surface morphology of the system [5]. Cement is a mixture composed of clay, limestone, and impurities such as magnesium and iron. The sintered mass of the CaO-SiO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> system is the product of grinding unbalanced cooling of many minerals. It contains phases such as impure tricalcium silicate (3CaO SiO<sub>2</sub> Alide). When cement is mixed with water, it reacts as a solvent, forming calcium, silicate, and aluminate ions in the intermediate solution. The microstructure of cement consists of grains and embedded micro hydrates, which are the products of the reaction of cement with water. The presence of polymers in hardened cement provides larger pores compared to cement alone, resulting in increased flexibility and strength for the material [6].

As the penetration depth increases, the scratch test shows a ductile-brittle transition. Scanning Electron Microscopy imaging reveals low porosity and a strong cement-binder intermediate, which traps and bridges cracks. For difficult procedures such as the Linear Theory of Nonlinear Fracture Mechanics breakdown in the fracture-driven regime, hardness is positively correlated. The fracture toughness of cement decreases as the cement ratio increases in macro-defect-free (MDF) conditions. Anhydrous cement lacks this fracture resistance, and decreasing the cement content can be explained by the increase in inter-particle distance. The microstructure of MDF cement exhibits fracture at the composite level, and the hardness value increases with the presence of calcium aluminate phases and granular micropores without overcrowded pores, as shown in [7]. Cement materials used for oil and gas well construction in underground systems, which require permanent isolation or filling when abandoned, should demonstrate excellent mechanical and durability characteristics on a large scale. Polymer powder/cement mixtures are typical cement-based products known to possess higher tensile strength, deformation resistance, adhesion, waterproofness, and durability. For this reason, polymer-modified cements are used in the construction industry, such as repair materials, corrosion coatings, or tile adhesives. Additionally, suitable polymer particles can be added to lighten emulsions without affecting their mechanical and durability properties, providing a way to achieve this. These reasons make polymer powder/cement compounds interesting materials for cementing [8]. Semi-powdered cements with absorbable polymer-absorbed theoretical water meet the requirements of homogeneity when the absorbable polymer-cement composition is approved by comparing it with absorbable polymer-free controls. In the case of absorbent polymer-cement composites, pore size decreased by 4.2 and 3.7 vol% for 0.85 and 1.0 wt% of absorbent polymer, respectively. The primary mean aperture size of absorbent polymer-cement composites is about 0.1mm hole radius [9]. Macro-defect-free (MDF) cement, a composite material where cement is the main ingredient and typically constitutes 80% of the solid composites, is created by adding small amounts of polymer and water to the mix. In the early stages, especially glycols like glycerol are often used to enhance the plasticity of the composites. MDF composites for rubber manufacturing are produced using an inspired method, where an elastic-plastic compound is sent between two rollers in the plant. High shear during this process helps eliminate macro voids. The obtained product is then pressed under pressure and temperature [10]. Particulate polymer composites, an important category of advanced reinforced materials used in electrical applications, have a multi-structure and utilize natural fillers to connect with the polymer matrix. Examples of these fillers include natural minerals, clay, zeolite, mica, talc, and deposits such as rocky shale. The cost-effective balance of assets is optimized by using competent affiliate agents and designing reinforcement. However, some physical and chemical factors, such as processing conditions, filler type, polymeric matrix nature, and interfacial adhesion capacity, can affect the machining of manufactured compounds and their electrical performance. As a result, filled with natural polymer composites are widely adopted in various applications [11]. Modern Building Materials Engineering aims to create materials with improved durability for cement structures, where minimal repairs are required. Material and technical solutions that facilitate the repair process are being sought. Concepts such as repair items already in use and self-healing properties are based on polymer compounds in cements [12]. Cement-polymer composite materials serve different purposes in building complexes and have varying requirements depending on the properties of existing materials. The development of regulatory and fresh dry mixes requires theoretical evidence. When considering functional combinations, it is important to select an appropriate binder and filler, understanding the principles of composition. Plaster, aggregates, masonry mortars, cement for emulsions, and forming composites of polymer materials in cement systems require a combination that modifies properties. Understanding the rules of composition and the necessary additions of polymers, including the composition of functional groups and their degree of polymerization, is crucial [13]. Currently, piezoelectric materials are used for structural analysis and monitoring purposes, and they can be classified into three categories: piezoelectric strain technology, wave transmission technology, and electro-mechanical impedance (EMI) technology. EMI technology, which is based on the electric impedance frequency spectrum of piezoelectric sensors, shows potential applications in mechanical engineering, civil engineering, and aerospace engineering fields [14]. Recycling plants face challenges due to the destruction caused by large-sized, low-density waste that takes up space on the landscape. However, by seeking value-added products, such as bridge decks, prefabricated curtains, wall panels, and floor blocks, cement-polymer composites can be used as overlays. These composites exhibit resistance to chemical attacks and have an acceptable mechanical life [15]. In laboratory-scale experiments, recycled post-consumer polystyrene foam waste and Portland cement were combined to form cement-polymer composites. The composites were solidified using Waste Solidification/Stabilization (S/S) as an integral matrix. The solid waste achieved solidification in tap water, ground water, and sea water for up to 420 days. The resulting solidified waste was evaluated for compressive strength, porosity, and mass conversion [16]. Polymers are commonly incorporated into cementitious mixtures in the form of aqueous solutions or dispersions, such as styrene butadiene rubber latex, epoxy resin, and polyacrylamide-like reagents. Acrylic resin-modified cement has been analyzed to summarize its mechanical behavior and found to exhibit improved strength and elastic modulus

compared to traditional cement. Progress has been made in replacing cement mortar with a new epoxy emulsion, which has shown improvements in compressive and flexural strength. Polyvinylpyrrolidone, a water-soluble polymer, has been used to reinforce Portland cement, resulting in increased braking pressure and energy due to an increase in molecular mass [17]. Cement and mortar are the main building compounds, and the success of the cement industry and advancements in technology have improved their quality. However, traditional cement production techniques make it challenging to reduce porosity due to the need for excess water. Cement stone is inherently porous, and the size of the solid phase neoplasms is typically insufficient to fill the initial voids under normal conditions [18]. Styrene butadiene, acrylic ester, and vinyl ester have been studied with doses of 45, 40, and 25 kilograms of EP-radiation, respectively, to determine their flexural strength and maximum values of the modulus of elasticity. The impact strength of the composites did not significantly improve above 10 kGy, nor did the hardness values for radioactive compounds compared to non-radioactive and controlled compounds [19]. In addition to cement mixtures, various studies have focused on using recycled polymer waste and plastic waste to reinforce cement. By adding shredded PET water bottles or different fiber types, the strength of cement mixtures can be further decreased or improved, respectively. Polymer composites are useful for improving the compressive strength and structural strength of cement, and they offer control over plastic shrinkage cracking [20].

**Calcium oxide:**

Calcium oxide (CaO), in general Called lime or quicklime is called, it is widely used is a chemical compound. This is the room White, caustic, alkaline, crystalline at temperature is a solid. Widely used The word lime means containing calcium refers to mineral substances, including calcium, Silicon, magnesium, aluminum and carbonates of iron, Oxides and hydroxides predominate are paying Instead, quicklime Especially the single chemical compound calcium Applies to oxide. such as cement Non-reactive processing in building materials Calcium oxide is called free lime is called Quicklime is comparable Cheaper. It and a chemical derivative Calcium hydroxide, including quicklime are basic anhydrides are important commodity chemicals.

**Magnesium oxide:**

Magnesium is what your body normally does An element that needs to function. Magnesium oxide for a variety of reasons can be used. Some have heartburn, Sour stomach or acid indigestion Used as an antacid to relieve pain. Magnesium oxide, for surgery Before, for short-term, rapid emptying of the bowels Can also be used as a laxative, for example. It should not be used repeatedly. Adequate amounts of magnesium in the diet In the absence of magnesium oxide a Also used as a food additive. Magnesium oxide is available without a prescription. Magnesium oxide as a tablet, , also available as a capsule. Any brand Used and in which position you are It depends on where you are Usually one to four daily method is taken. in the package instructions or your prescription Follow the instructions on the slip label Follow carefully, you don't understand Explain any part of your Ask your doctor or pharmacist. Properly administered magnesium oxide Take it. Your doctor More than recommended or Don't settle for less or don't take it too often.

**Silicon dioxide:**

Silicon dioxide is silicon and natural of oxygen It is a chemical compound that is used in many foods as an anticaking agent in ingredients is used. Silicon dioxide Generally safe as a food additive, however some agencies in foods of silicon dioxide found Regarding quality and characteristics demanding strict guidelines.

**Aluminum oxide:**

Aluminum oxide is  $Al_2O_3$  with the chemical formula of aluminum and oxygen is a chemical compound. It is many Most commonly occurs in aluminum oxides And aluminum in particular is identified as an oxide. It is commonly known as alumina and specific forms or Alaxide or Alundum depending on the applications Also known as It is natural  $\alpha-Al_2O_3$  in its crystalline polymorphic phase Occurs as the mineral corundum, of which Varieties Precious Gemstones Ruby and form sapphires.  $Al_2O_3$  is aluminum metal Notable in producing, its Abrasion due to hardness Asa substance, high melting point As a result, it is a useless item.

**Sodium oxide:**

Sodium oxide is  $Na_2O$  is a chemical compound with the formula It's on ceramics and glass is used. It is a white A solid but rarely a compound is faced. instead Sodium oxide, sodium and others containing oxides containing elements Like glasses and fertilizers Components of various products Used to describe. Sodium oxide What is sodium oxide glass and in the manufacture of ceramic products is used. Anhydrous sodium By adding water to the oxidn It is also used in the production of sodium hydroxide.

**Potassium oxide:**

Potassium oxide (K<sub>2</sub>O) is of potassium and oxygen is an ionic compound. This is a basic. This light-yellow solid is of potassium is the simplest oxide. This is A highly reactive compound, It is rarely seen. Fertilizers and some like cements for industrial products, K<sub>2</sub>O Assuming equal percentage composition are evaluated.

**Sulfur trioxide:**

Sulfur trioxide alternative spelling Sulfur trioxide, Nisso Also known as sulfon, It has the formula SO<sub>3</sub> is a chemical compound. It is "for doubt Very economically without space Described as important" sulfur oxide. It is a precursor to sulfuric acid Produced on an industrial scale. Sulfur trioxide is many exists in the forms gaseous monomer, crystalline trimer and solid polymer. Sulfur Dry Oxide is relatively short A chamber with a liquid limit is a solid below temp. The gas SO<sub>3</sub> is the primary precursor to acid rain.

**Result and Discussion:-****Table1:-** Reliability Statistics.

Reliability Statistics			
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Based on	N of Items
.686	.690		7

Table 1 shows the Cronbach's Alpha Reliability result. The overall Cronbach's Alpha value for the model is .686 which indicates 68% reliability. From the literature review, the above 69% Cronbach's Alpha value model can be considered for analysis.

**Table 2:-** Reliability Statistic individual.

	Cronbach's Alpha if Item Deleted
Calcium oxide	0.642
Magnesium oxide	0.68
Silicon dioxide	0.637
Aluminum oxide	0.598
Sodium oxide	0.613
Potassium oxide	0.637
sulfur trioxide	0.729

Table 2 Shows the Reliability Statistic individual parameter Cronbach's Alpha Reliability results Calcium oxide 0.642, Magnesium oxide 0.68, Silicon dioxide 0.637, Aluminum oxide 0.598, Sodium oxide 0.613, Potassium oxide 0.637, sulfur trioxide 0.729

**Table 3:-** Descriptive Statistics.

Descriptive Statistics														
	N	Rang e	Minim um	Maxim um	Sum	Mean	Std. Deviat ion	Varia nce	Skewness	Kurtosis				
	Statis tic	Statis tic	Statisti c	Statisti c	Statis tic	Statis tic	Std . Error	Statisti c	Statist ic	Statis tic	Std . Error	Statis tic	Std . Error	
Calciu m oxide	20	4	1	5	60	3.00	.241	1.076	1.158	-.563	.512	.232	.992	
Magnes ium oxide	20	4	1	5	59	2.95	.246	1.099	1.208	.636	.512	.102	.992	
Silicon dioxide	20	4	1	5	62	3.10	.315	1.410	1.989	.055	.512	-1.154	.992	
Alumin um oxide	20	4	1	5	61	3.05	.235	1.050	1.103	-.108	.512	.567	.992	
Sodium	20	4	1	5	68	3.40	.32	1.429	2.042	-.197	.51	-	.99	

oxide							0				2	1.322	2
Potassium oxide	20	4	1	5	70	3.50	.303	1.357	1.842	-.070	.512	-1.405	.992
sulfur trioxide	20	4	1	5	64	3.20	.277	1.240	1.537	-.420	.512	-.300	.992
Valid N (listwise)	20												

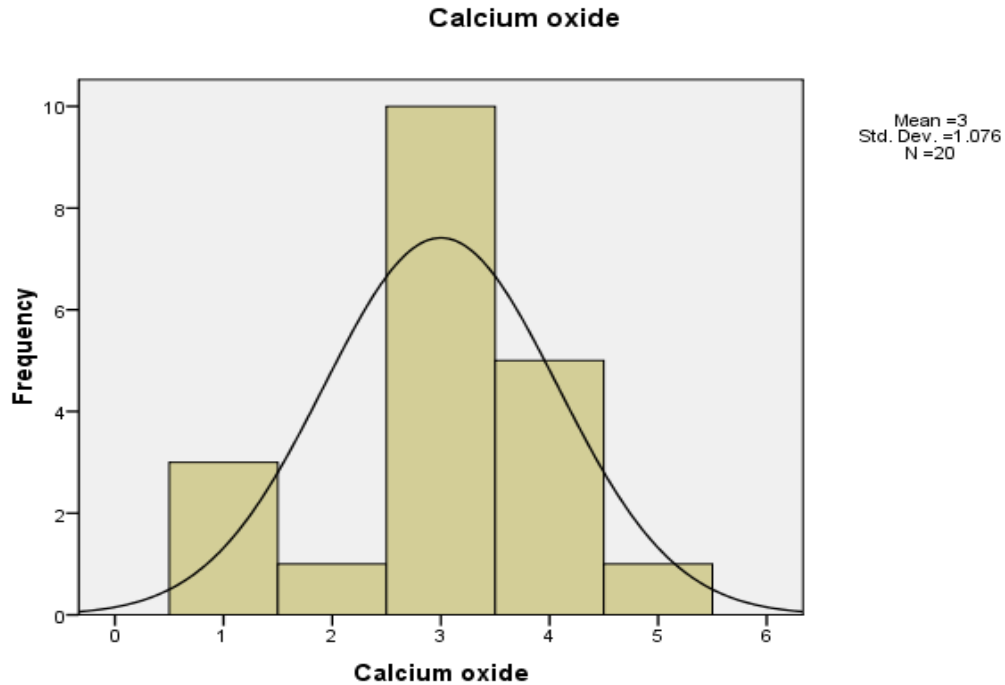
Table 3 shows the descriptive statistics values for analysis N, range, minimum, maximum, mean, standard deviation, Variance, Skewness, Kurtosis. Calcium oxide, Magnesium oxide, Silicon dioxide, Aluminum oxide, Sodium oxide, Potassium oxide, sulfur trioxide this also using.

**Table 4:-**Frequency Statistics.

Frequency Statistics								
		Calcium oxide	Magnesium oxide	Silicon dioxide	Aluminum oxide	Sodium oxide	Potassium oxide	sulfur trioxide
N	Valid	20	20	20	20	20	20	20
	Missing	4	4	4	4	4	4	4
Median		3.00	3.00	3.00	3.00	3.00	3.00	3.00
Mode		3	3	3	3	5	5	3
Percentiles	25	3.00	2.00	2.00	3.00	2.00	2.25	3.00
	50	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	75	4.00	3.00	4.75	3.75	5.00	5.00	4.00

Table 4 Show the Frequency Statistics in Cement polymer composites is Calcium oxide, Magnesium oxide, Silicon dioxide, Aluminum oxide, Sodium oxide, Potassium oxide, sulfur trioxide curve values are given. Valid 20, Missing value 4, Median value 3.00, Mode value 3.

**Histogram Plot**



**Figure 1:-** Calcium oxide.

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

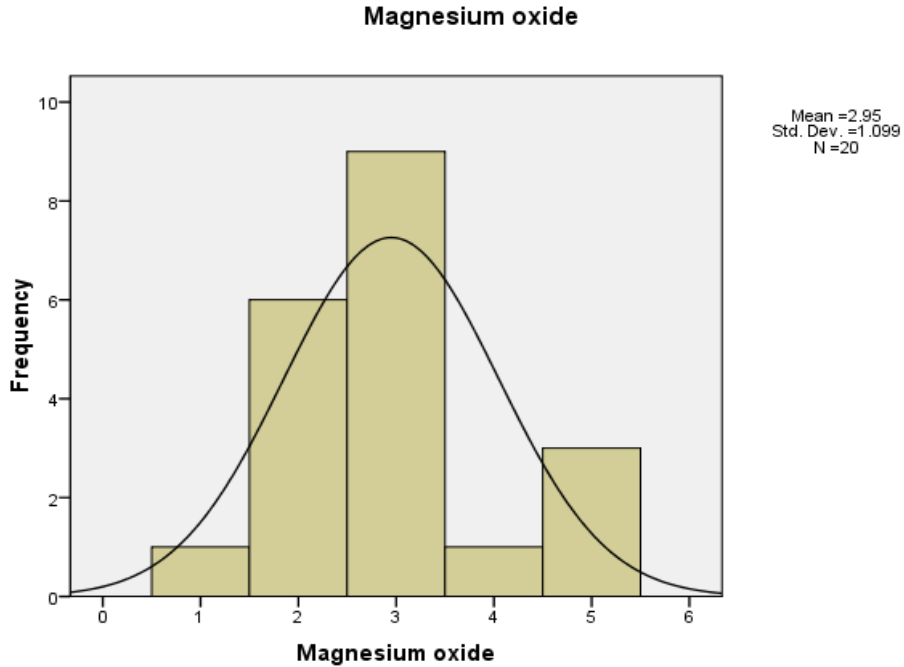


Figure 2:- Magnesium oxide.

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

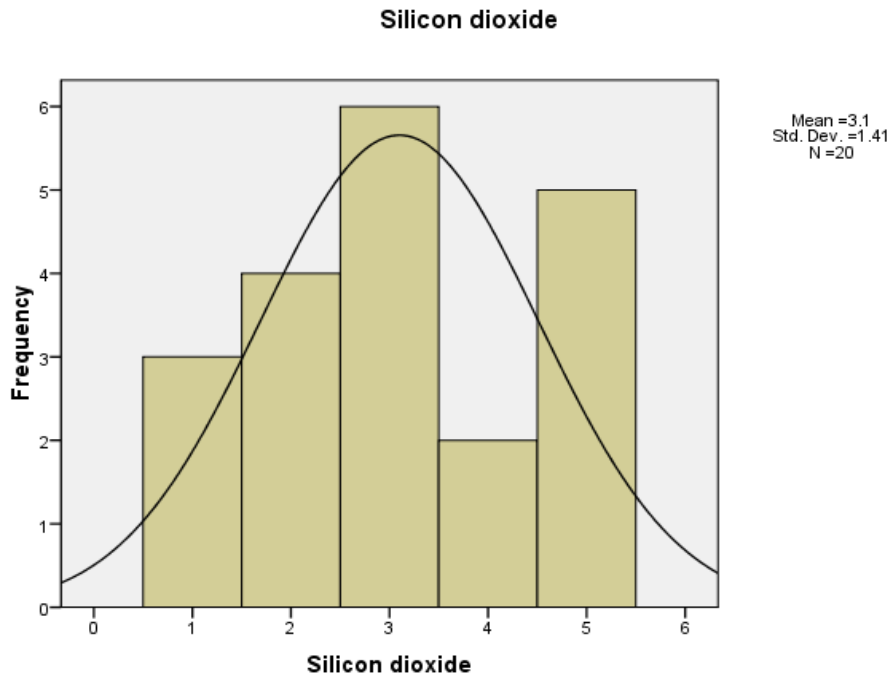


Figure 3:- Silicon dioxide.

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

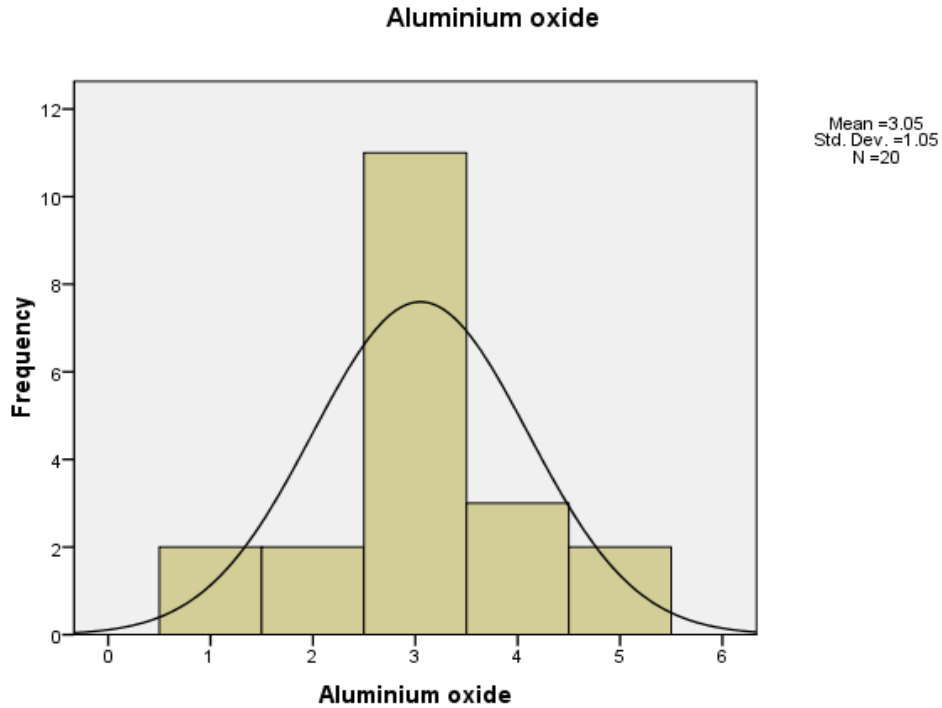


Figure 4:-Aluminum oxide.

Figure 4 shows the histogram plot for Aluminum oxide from the figure it is clearly seen that the data are slightly Bell karo due to more respondent chosen 3 for Aluminum oxide except the 3 value all other values are under the normal curve shows model is significantly following normal distribution.

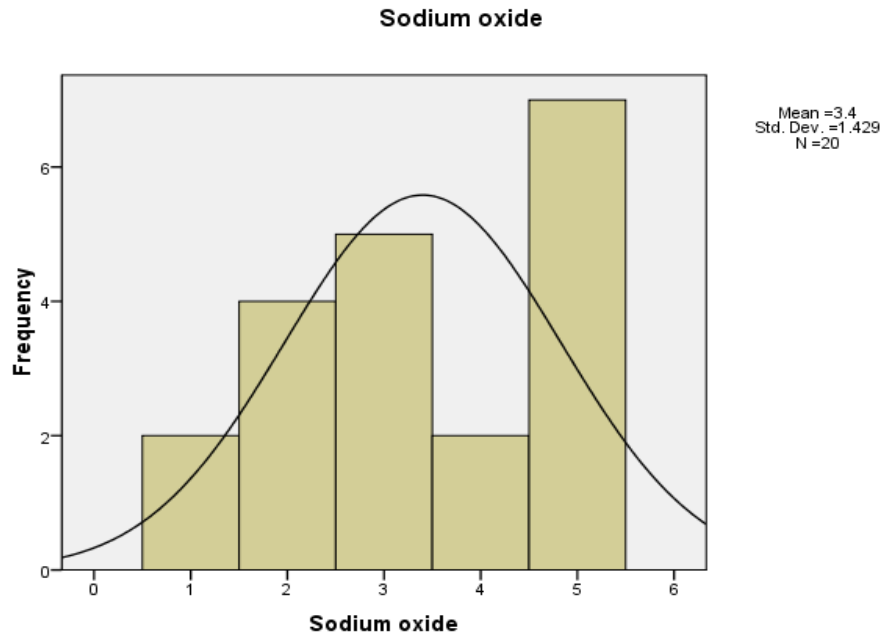
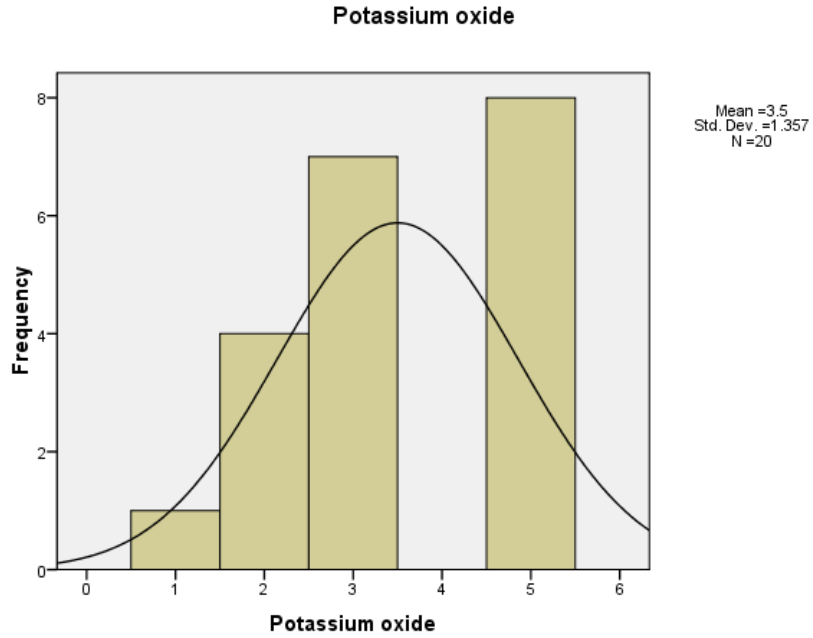


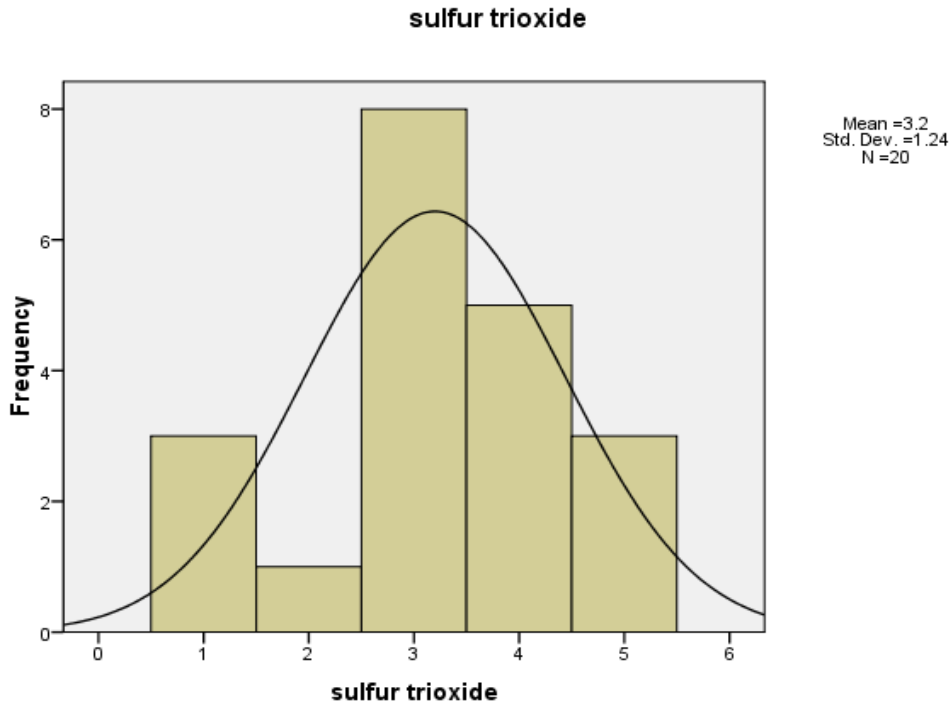
Figure 5:- Sodium oxide.

Figure 5 shows the histogram plot for Sodium oxide from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 5 for Sodium oxide except the 2 value all other values are under the normal curve shows model is significantly following normal distribution.



**Figure 6:-** Potassium oxide.

Figure 6 shows the histogram plot for Potassium oxide from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 5 for Potassium oxide except the 1 value all other values are under the normal curve shows model is significantly following normal distribution.



**Figure 7:-** sulfur trioxide.

Figure 7 shows the histogram plot for sulfur trioxide from the figure it is clearly seen that the data are slightly Left skewed due to more respondent chosen 3 for sulfur trioxide except the 2 value all other values are under the normal curve shows model is significantly following normal distribution.

**Table5:-** Correlations.

<b>Correlations</b>							
	<b>Calcium oxide</b>	<b>Magnesium oxide</b>	<b>Silicon dioxide</b>	<b>Aluminum oxide</b>	<b>Sodium oxide</b>	<b>Potassium oxide</b>	<b>sulfur trioxide</b>
Calcium oxide	1	0.223	0.173	0.373	0.308	0.36	0.158
Magnesium oxide	0.223	1	0.241	0.185	0.315	0.3	-0.263
Silicon dioxide	0.173	0.241	1	.494*	0.319	0.137	0.259
Aluminum oxide	0.373	0.185	.494*	1	0.337	0.277	.477*
Sodium oxide	0.308	0.315	0.319	0.337	1	.624**	-0.107
Potassium oxide	0.36	0.3	0.137	0.277	.624**	1	-0.125
sulfur trioxide	0.158	-0.263	0.259	.477*	-0.107	-0.125	1
*. Correlation is significant at the 0.05 level (2-tailed).							
**. Correlation is significant at the 0.01 level (2-tailed).							

Table 5 shows the correlation between motivation parameters for Calcium oxide For Aluminum oxide is having highest correlation with Potassium oxide is having lowest correlation. Next the correlation between motivation parameters for styrene Magnesium oxide For Sodium oxide is having highest correlation with sulfur trioxide is having lowest correlation. Next the correlation between motivation parameters for styrene Silicon dioxide For Aluminum oxide is having highest correlation with Potassium oxide is having lowest correlation. Next the correlation between motivation parameters for styrene Aluminum oxide For Silicon dioxide is having highest correlation with Magnesium oxide is having lowest correlation. Next the correlation between motivation parameters for styrene Sodium oxide For Potassium oxide is having highest correlation with sulfur trioxide is having lowest correlation. Next the correlation between motivation parameters for styrene Potassium oxide For Sodium oxide is having highest correlation with sulfur trioxide is having lowest correlation. Next the correlation between motivation parameters for styrene sulfur trioxide For Aluminum oxide is having highest correlation with sulfur trioxide is having lowest correlation.

### **Conclusion:-**

Polymer cement is a typical type of cement binder that consists of cement hydrate and polymer binders or liquid resins. It is a composite material produced by complete conversion, and it belongs to the category of cement-polymer composites. Polymer cement is a composite material in which the binding material contains synthetic polymer. Polymer cement has high properties, low power requirements, and low labor costs, which are its advantages. Polymer concrete was introduced in the late 1950s and gained popularity in the 1970s for repairs, thin overlays, platforms, and precast elements. Polymer-modified concrete offers many benefits, such as increased strength and durability. The strength of the concrete mixture is related to the amount of water used, known as the water-cement ratio. Decreasing the water-cement ratio increases the strength. Additionally, polymer-modified concrete requires less water. However, concrete is not without its flaws. It can be affected by various conditions, leading to cosmetic issues or structural failures. The Cronbach's Alpha reliability result of the model indicates an overall value of 0.686, which suggests 68% reliability. Based on the literature review, the model with a Cronbach's Alpha value of 0.69 can be considered for analysis.

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