Neoteric Method For Production Of Cement Using Coal Slurry As An Alternative Raw Material And Its Impacts

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DEDICATED TO OUR BELOVED PARENTS, ADVISER, TEACHERS

CO-ADVISORS, AND ALL THOSE WHO HAVE CONTRIBUTED IN THIS PROJECT

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Abstract

Coal slurry is the coal waste in liquid form which is generated by using mining sports inclusive of coal washing. After mining, coal is beaten up into small pieces and washed, thus results the generation of solid waste as well as liquid waste in huge amount. The aim of this paper is to analyze the use of coal slurry waste from Dar-E-Adam Khel, KPK in cement. The consequences confirmed that coal slurry waste can be used to prepare clinkers for preparation of cement.

The coal slurry waste become combined into raw combination with specific proportions. Different samples of raw meal were formed by the addition of coal slurry waste in 1% ,2% and 3% by weight. Many characteristics and properties like burnability index, gaseous emission and their quality, most important phases of clinker like alite, belite etc. were considered, amount of free lime and chemical composition of coal slurry waste is well matched with the standard sample of cement clinker of askari cement Wahh Cantonment. Portland cement clinker prepared without coal slurry waste mean the standard of askari cement Wahh Cantonment. has unbonded lime and burnability index test consequences were higher than coal slurry containing clinker. These findings advise that coal slurry waste facilitate burnability and rate of reaction of raw material to form cement rises making process economical. By noticing that replacing 3% weight coal slurry waste can be used as raw material to produce cement with good properties of clinker.

One most important finding of this analysis was the most important phases of cement which are Alite, Belite, Tricalcium aluminate and tricalcium alumina ferrite was in the range and are comparable with standard of askari cement.

All these findings recommend the usage of coal slurry as it is economical as well as compatible and most importantly includes the usage of waste which is harmful for the environment.

Chapter 1 Introduction

1.1. GENERAL

Coal is a combustible black or brownish-black sedimentary rock. Coal is frequently carbon with other variables and even sometimes include dust sometimes.

Coal is shaped when useless plant be counted decays into peat and is transformed into coal by using the warmth and stress of deep burial over millions of years. As a fossil fuel burned for heat, coal supplies about a quarter of the world's primary power and two-fifths of its electricity.

The extraction and usage of natural resource present in abundant amount reasons many untimely deaths and plenty illness. The coal enterprise damages the environment, and nearly 25% of total global greenhouse gasoline emissions.

1.2. WASTE OF COAL SLURRY

Before transportation of coal to the market, coal is excavated from the soil and rocks, then it is washed. The washing of coals leaves residue of coals on the ground, through mining billions of coals is generated. The agencies built dams to tackle these kind of wastes for example, impoundments of coals or which is also known as ponds, in a cheap way to store billions of coal waste in liquid form.

Coal groups say the sludge incorporates by and large water, rocks and mud. But it also consists of carcinogenic chemical compounds

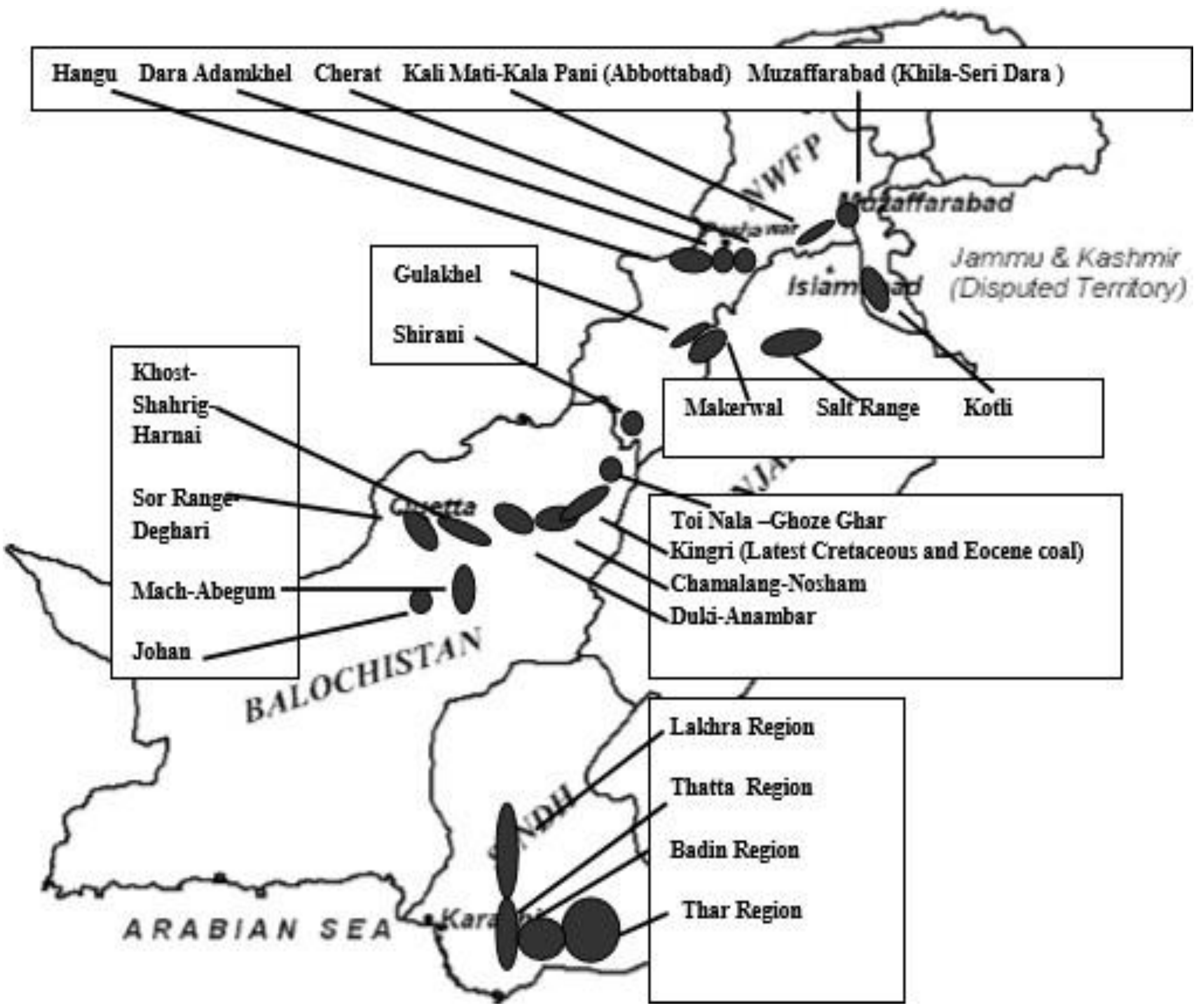
Substances of chemicals like this can penetrate from the ponds of coal slurry waste into the near-by water bodies, or ground or near water table, which can harm the ground and all the communities living near-by it. This can cause a freash water into the harmful water leaving many diseases.

Coal slurry in liquid state

1.3. COAL AND COAL SLURRY PRODUCTION

It is estimated that 186.28805 billion of tons of coal reserve is present in Pakistan making the position of 20th in the whole world. The Pakistan can use its coal for next 331 years only if we exclude the unproven reserves of Pakistan.

REGIONS:



Hangu
Dara Adamkhel
Cherat
Kali Mati-Kala Pani (Abbottabad)
Muzaffarabad (Khila-Seri Dara)
NWFP
Muzaffarabad
Jammu & Kashmir
(Disputed Territory)
Gulakhel
Shirani
Khost-
Shahrig-
Harnai
Sor Range-
Deghari
Mach-Abegum
Johan
Makerwal
Salt Range
Kotli
Quetta
Toi Nala –Ghoze Ghar
Kingri (Latest Cretaceous and Eocene coal)
Chamalang-Nosham
Duki-Anambar
BALOCHISTAN
Lakhra Region
Thatta Region
Badin Region
Thar Region
SINDH
ARABIAN SEA

1. BALOCHISTAN:

Chama Lang, Kangri (K-T), Narwal-DabToi, Pir Ismail Ziarat, Nala- Ghoze Ghar, Sor Range- Deghar, Khost-Sharig- Harnai, Mach-Begum, Duki-Anamba, , , Johan.

2. PUNJAB:

Makerwal, Salt Range

3. SINDH:

Ongar, Thar, Lakhra, Sonda-Thatta, Meting-Jhimpir, Indus East, Jherruck, Badin.

Thus, as there is lot of mining in different areas of Pakistan Approximately one-billion-ton mining of coal produce 1 to 10 million ton of slurry.

1.4. Problem statement

The production of various construction materials like cement has damaged the environment and atmospheric zones by releasing of gases that even cause acid rain continuously. High amount of Carbon monoxide, oxides of nitrogen and calcium, Sulphur, etc. are emitted. These kinds of gases which are emitted can cause serious pollution of air, water and soil.

Waste of coal slurry is one of pollutant by these industries. When the coal is mined, coal is washed through the liquid for cleansing purpose, is overwhelmed. By cleaning and washing the coal, it generated a huge amount of coal slurry waste in liquid of stable waste. Study shows that coal slurry waste can be used in different fields. However, utilization of coal slurry in most growing industry like cement was hardly ever researched and it changed into visible that literature and industrial research for the usage of in cement production became limited. Preparation of clinkers of Portland cement in the scale of industry was changed when the coal slurry usage was introduced; we obtained from the Dar-e-Adam Khel. After characterization of waste materials, the capability use of coal slurry might be calculated to not only reduce the environmental hazards however additionally to decrease the producing coast of cement guidance.

1.5. Aims and Objectives

- To economize the cement production by neoteric method
- To reduce the hazardous effects of CSW
- To introduce a neoteric method for cement production.
- To enhance the strength of cement using coal slurry.

Chapter 2 Literature Review

2.1. Use of wastes of coal slurry to produce the clinkers of Portland cement as an alternative raw material (Ziypak)

Theory 1

According to Turkish documents, they worked on coal sludge in their field. Liquid Coal waste is produced from the coal waste, it is arises from activities after mining for example washing of coal. From mining of coal, it is mined, crushed, and washed. From the washing of coal, it produces of huge amount of coal waste in liquid and solid form. The Turkish coal companies intends for the use of coal slurry waste to produce the Portland cement clinkers as in alternative source of raw materials in industries and laboratories. From the various experiments it is cleared that usage of coal slurry waste to cement clinkers is economical and feasible in and every respective way. Waste of Coal was used in raw materials in the proportions of different values at one wt.%, two wt.% and three wt.% according to weight, clinker key stages, combustion index, chemical composition, density, free lime, and point comparison of the exhaust emissions of gases from the coal being used in the preparation of cement clinkers from the previous raw materials of past. From the experiments it was cleared that chemical composition of coal slurry waste was same as of raw materials were being used for the manufacturing of cement clinkers. The clinkers' main components such as ballite (C2S), Ellite (C3S), tri calcium aluminate (C3A) and tetra calcium alumino ferrite (C4AF), are in the acceptable range of for the manufacturing of cement clinkers. Portland cement slag without charcoal lime and better results of the flammability index

More dirt from charcoal with clinker. This shows that burning process is increased and rate of burning is greater. Moreover, addition of CSW does not have any significant impact on gases emitted. It has been observed that the conversion of coal waste into 3% wt. as an alternative raw material has a positive effect on the production of Portland clinker cement (ZIPAK).

2.2. Utilization of coal gangue and copper tailing in cement clinker calcinations (Qiu)

The use of cement clinker was experimentally tested to avoid contamination of the environment by the coal gang and copper waste. Limestone with the low calcium was also studied through SEM and XRD at microscopic level to produce cement clinkers as alternative raw materials. From the results of experiments, it was cleared that qualified cement can be prepared by replacing a mixture of charcoal strips and clay carbon tape. Coal cutters and coal strips can supply oxygen-rich minerals and geothermal rocks. When mixed with limestone with a high calcium content and limestone with a low calcium content, the calcification temperature was 50 ° C or 100 km underground. The energy of the coal gang and the reduction in coal consumption suppress the coal and coal tail gangs as well as the low calcium recycling for limestone, coal duct and coal cutters.

2.3. **Recycling of municipal solid waste for cement production** (Marroccoli).

The community collects a large part of the solid ashes from landfills. Reducing resource consumption and waste recycling are key factors for human well-being in the future. The study presented in this article relates to technologies for the production of cement from municipal waste incineration ash, sewage sludge incineration and other waste such as aluminum slag and copper slag. Since the ashes from the incineration of municipal waste contain chlorine, special attention should be paid to the installation of chlorine in the cement.. Appropriate treatment (formation of calcium aluminate chlorine) has been confirmed to treat chlorine. Before using technology on an industrial scale, a pilot-scale test (50 tons / day) was tested to ensure its usefulness. As a result, the cement quality is sufficient to put the cement into practice. In addition, the test process does not cause secondary pollution. As a result, 50% of the raw materials for cement production can be obtained from the ashes of the incineration of solid municipal waste.

2.4. COAL

Charcoal is a black or very flammable black-brown rock that consists of heavy carbon and hydrocarbons. Coal is listed as a non-renewable energy source because it takes millions of years to produce it. As a result, pressure and heat turned plants into what we call coal. Coal contains very important applications around the world. The main coal applications are in the areas of power generation, cement production, steel production and liquid fuel. Steam coal or thermal energy is mainly used to generate electricity. Coal is a solid black stone that can be burned like solid fuel. It is mainly carbon, but contains sulfur, hydrogen, nitrogen and oxygen. It is made from the stomach and then pressed when laying the stone formation.

Coal was created millions of years ago when huge forests covered the world, when huge plants, reeds and mesa grew. Some of them died as soon as the plants grew and fell into the swamp water. New plants grow and replace old ones, and after the death of earlier plants, their growth continues. Over time, a thick layer of dead plants formed in these swamps. The earth's crust began to change and the water and soil began to wash off, which stopped the caries process. More and more plants started to grow, but fell and died, creating separate layers. After millions of years of this process, several layers formed on top of each other. The weight of each layer, dirt and water, depends on the lower layers of the plant material. In plant layers, pressure and heat lead to physical and chemical changes that consume oxygen and release rich carbon deposits. Plants turned into charcoal over time.

2.5. CHARACTERISTICS

Coal is a solid volatile substance with different pores. Fine pores are the main type of pores. Coal is petrified black fossil fuel. It is partially formed by rotting and changing the shape of the plant material. Under high pressure and high temperature, the formation took millions of years.

The various substances of plants to the extent that they determine the compounds present in the decomposing coal such as vitrine, clarinet, during and fusion.

2.6. CHEMICAL PROPERTIES

In coal, organic materials mainly consist of small amounts of carbon, oxygen, hydrogen, nitrogen, sulfur and some other elements. Carbon, hydrogen and oxygen make up more than 95% of the fossil organic matter. In coal, organic materials mainly consist of small amounts of carbon, oxygen, hydrogen, nitrogen, sulfur and some other elements. Carbon, hydrogen and oxygen make up more than 95% of the fossil organic matter.

2.7. TYPES

When coal is formed, the hole is drilled in which organic matter is decomposed deep underground. The heat and pressure of the burial changes the structure and increases the carbon content in the stomach, making it a kind of sedimentary rock and coal. This course takes millions of years.

The carbon content determines coal or "qualities". There are four types of coal, the amount of which ranges from low to high.

1. Anthracite, also known as "hard coal", contains the highest amount of carbon (86% -97%) in all coal qualities. She has a tender feeling and lust. Due to the high heat costs, it is mainly used in industrial processes and in the metal industry.

2. Hard coal, which is commonly referred to as "soft coal" and contains slightly less carbon than anthracite (45% to 86%). A wide range of carbon materials use bituminous coal guarantees for energy and steel making. It is famous for its shine and layers.3. Sub-bituminous coal is not the same polished luster as higher rated coals do. This has a smaller carbon content than bituminous coal (35 percent -45 percent), as the name implies, which is primarily used for power generation.

3. Lignite is often referred to as "lignite" because it has a lighter color than high-quality coal. It contains the lowest carbon content (25% -35%) of all coal grades and has a strong moisture content and a sparse texture.

2.8. COALS IN PAKISTAN

Region	Coal (billion tonnes)
Sindh: Lakhra, Sonda, Thatta, Jherruck, Thar, Haji Coal and others	184.623
Punjab: Eastern Salt Range, Central Salt Range, Makerwal	0.235
Balochistan: Khost-Sharig-Harnai,Sor Range/Degari, Duki, Mach- Kingri, Musakhel Abegum, Pir Ismail Ziarat,Chamalong	0.217
KPK:	0.092
AJK:	0.009
Grand total	185.175

2.9. POPULATION DUE TO COAL

Environmental problems from burning coal. In the past, the focus on SO_2 and NO_x was the main pollutant that affects acid rain. In particular, the causes of air emissions, cancer and premature death. Flux gas emissions can eliminate sulfur dioxide and selective catalytic reduction (SCR) can remove NO_2. Electro filters can remove particles. Despite the fact that these less effective wet scrubbers can remove gases and particles. Mercury contamination can be reduced by up to 95%, but it is not economically feasible to reserve CO_2 emissions commercially.

2.10. COAL SLURRY AND SLUDGE

Composition:

Coal sludge ampoules, known as "ponds", has ability to store billions of gallons of liquid coal waste. Coal producers claim that clay mainly consists of water, clay and stones.

The sewage pipe is a pipeline that is specially designed for the transportation of materials such as coal or iron, coal waste or waste over long distances. A mixture of mineral concentration and water is transferred to the target or clay and the water is extracted.

Coal slurry is a solution of pressurized coal and liquids like water or gasoline. Solid coal waste or environmentally harmful fuels consist of 65 to 75% iron, most of which is methanol as fuel.

2.12 AVAILABILITY OF COAL SLURRY IN PAKISTAN

Coal waste is an alternative fuel that is normally provided by factories abroad. Unfortunately, there are no factories in Pakistan that are the only wastes that arrive here in Pakistan and that arise during the mining phase when water is sprayed into the mines that produce the wastes. Then the dirt near the construction site is collected by pipes, trenches, etc. Since the accumulation on the mine site, however, no specific dirt application has been written.

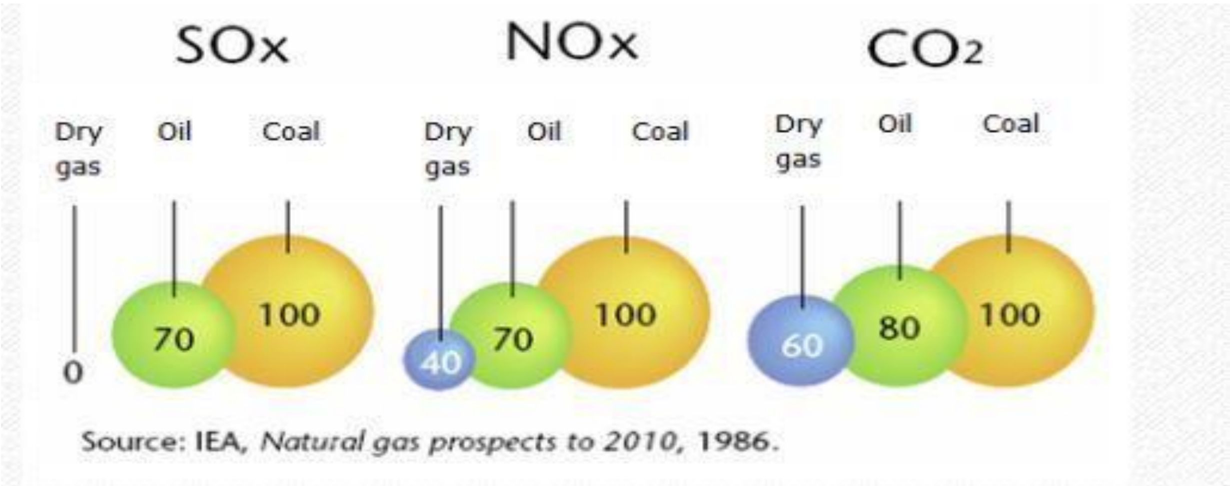
2.13 ENVIRONMENTAL HAZARDS OF SLURRY:

One of the most effective and unpredictable natural disasters is the coal mine, which developed a massive, fast-moving swamp in Blackwater. Various gases such as methane, hydrogen sulfide, ammonia and carbon dioxide are released. Many of these gases have an unpleasant smell and some have a weak smell.

Hydrogen sulfide is more effective because it not only damages the nervous system, but often creates an unpleasant smell from the eggs, which can be strong or moderate depending on the intensity of the gas and how much. The breath filled with this toxic gas or the sudden death from the lungs leads to death. If you are in this area, you will not give up the slightest hope in life.

Gases are heavier than air, replacing the oxygen that causes suffocation and death. Many gases can be odorless and therefore go unnoticed, resulting in low oxygen consumption without anyone noticing. But if worker and individuals are to take action Avoid these accidents, and this doesn't mean that they can guarantee safety if one of them happens.

Burning coal releases various gases that can later become a source of potential acid rain. The two main pollutants of gases are SOx, NOx and CO2. Coal contains the largest amount of these specific gases compared to all other natural resources in the world



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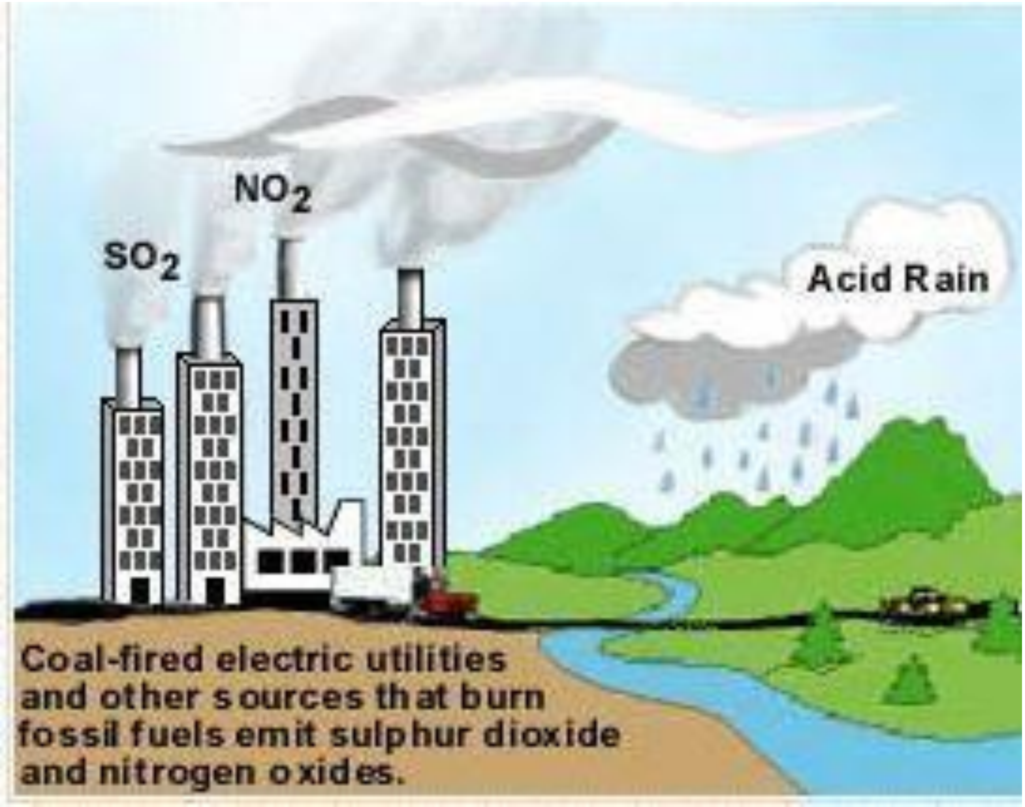


2.14 CEMENT:

Portland cement (OPC) is the main building element. Concrete is created when Portland cement produces a water paste that hardens with sand and stones.

Cement consists of a carefully controlled mixture of calcium, silicon, magnesium, iron and other components.

Common cement products are axes, fossils, chalk or marl, including veneer, stone, high furnace slag, slate, iron and quartz sand. After heating to high temperatures, these materials form a stone-like substance that is contained in a fine powder, which we generally consider to be cement.

Cement is used as a binder in the construction sector, and innovations in the design world have proven to be innovative.

Before the modern era, Joseph Spadeen, a British construction worker, developed cement in 1824 and experimented with heating and heating the clay until the material was roasted, ground and then mixed with water.

2.15. INGREDIENTS AND COMPOSITION:

The main features of these cement ingredients along with their functions and usefulness or harmfulness are given below:

Lime:

Calcium hydroxide or calcium oxide is called lime.

A lot of lime is required to manufacture the elements and silicates. Lime deficiency reduces the strength of the cement, which leads to faster cement stability. It also makes cement baseless. Excess lime causes cement to collide and expand.

Silica:

Silicon dioxide or silicon dioxide is the chemical CO_2 formula. Silica must contain a lot of silica. Silica strengthens the cement. It is contained in about 30% of the cement.

Alumina:

Alumina in the chemical formula Al_2O_3. This gives the properties of a quick cement fixation. Since it already exists, the recording temperature is reduced. Excess aluminum oxide weakens the cement

Magnesia:

Magnesium oxide. Its formula is MGO. More than 2% of the magnesia are not found in the rock. Excessive magnesia reduces the cement strength.

Iron oxide:

Fe2O3. Iron oxide is a chemical formula that gives the color of cement. It works like a river. Calcium and aluminum lead to the formation of aluminum ferrite in a chemical reaction at high temperatures. Ferrite alumina provides the hardness and strength of triclosan cement.

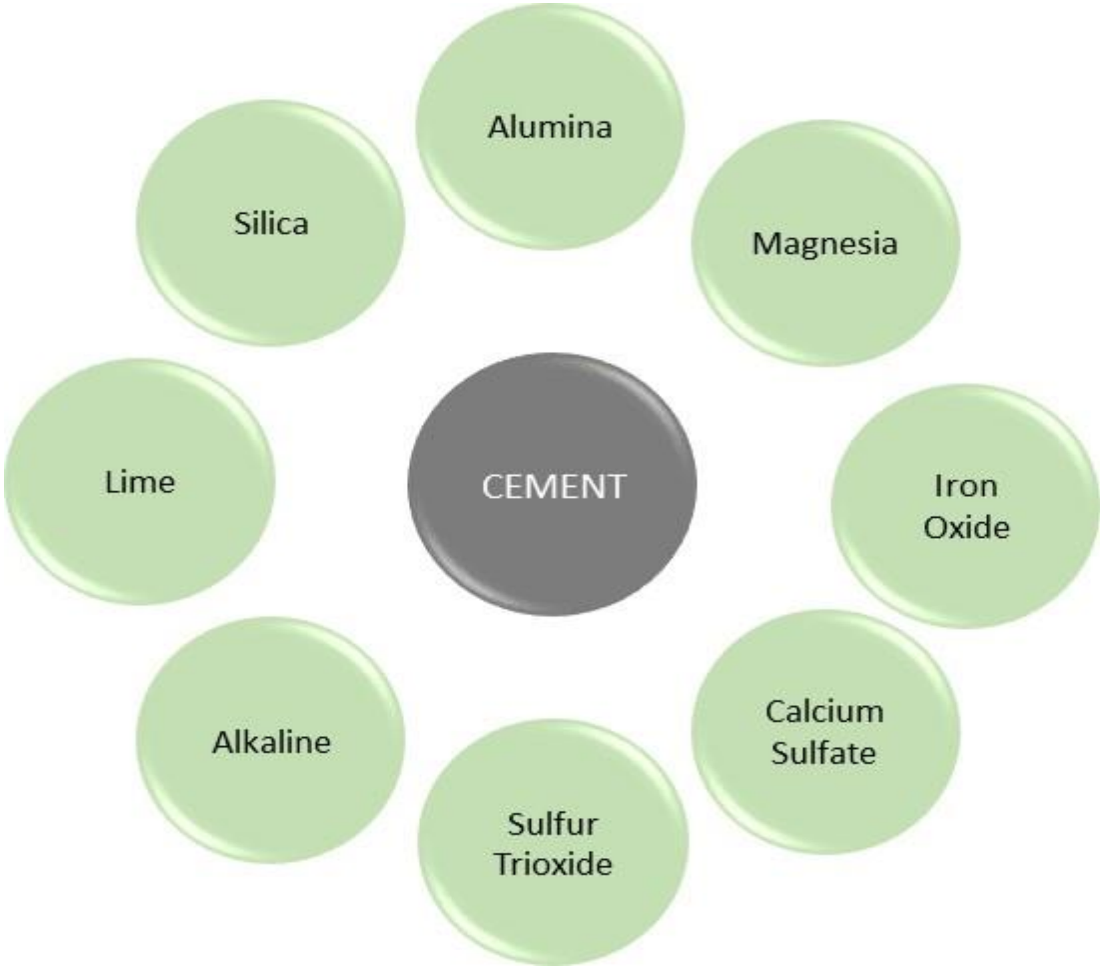
Calcium sulfate:

The chemical formula CaSO4 occurs in cement in the form of gypsum (CaSO4.2H2O), which delays or prevents the formation of cement.

Sulfur trioxide: The chemical composition is SO3, no more than 2% can be found. Excess sulfur oxide creates basic cement.

Alkaline:

It will not be present in amount greater than one. Efflorescence induces excess alkaline content.



2.16 TYPES OF CEMENT:

Cement is a versatile and complex structure with interchangeable compounds and properties

THE Six Types OF Cement

Type I

Ordinary Portland Cement (OPC) general purpose cement with no special properties.

Type IP

Blended Cement (Pozzolan) general purpose cement used for concreting and plastering.

Type II

Used when mild sulphate resistance and/or a moderate heat of hydration is required.

Type III

Classified as a rapid hardening cement, finer than Type I.

Type V (SR)

A high sulphate resisting (SR) cement, gains strength at a slower rate than type II and I.

Class "G" Oil Well Cement

Specialty cement made for Oil and Gas industry, special behavioural properties for high temperature and pressure applications.

2.17 Percentage of Composition of Ordinary Portland Cement:

Cao	61.98%
SiO2	20.21%
Al2O3	4.53%
Fe2O3	4.43%
MgO	2.15%
K2O	0.46%
Na2O	0.22%
SO3	2.10%
LSF	93.35%
SM	2.25%
AM	1.02%
C3S	57.15%
C2S	16.09%
C3A	4.60%
C4AF	13.78%
LOI	3.81%
IR	0.81%

2.18 Component Composition

3CaOSio2	C3S	62.74%
2CaOSiO2	C2S	10.44%
3CaOAl2O3	C3A	4.1%
4CaOAl2O3Fe2O3	C4AF	14.08%

2.19 Analytical Composition

SiO2	21.14%
Al2O3	4.5%
Fe2O3	4.53%
CaO	63.62%
MgO	2.9%
K2O	0.89%
Na2O	0.11%
SO3	2.2%
Cl	0%

CHAPTER 03

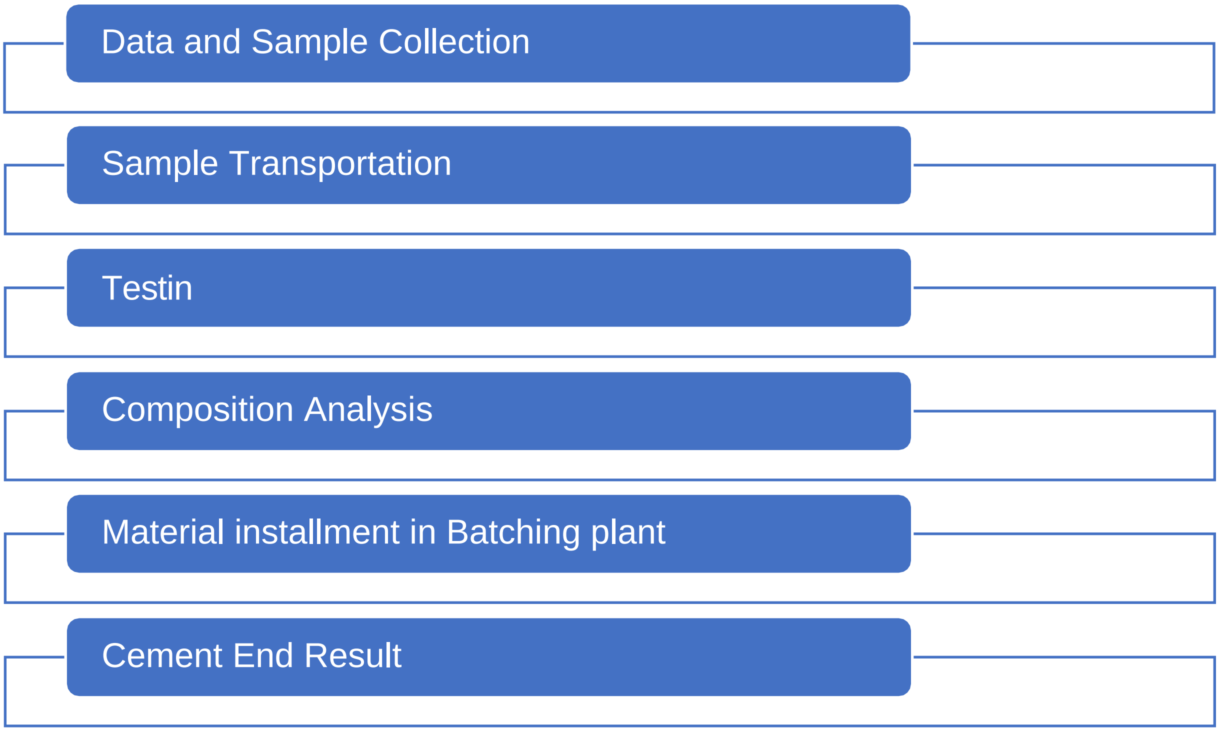
METHODOLOGY AND DATA COLLECTION

This chapter describes various techniques and approaches which have been followed to perform the investigation

Methodology of the Project:

Following collection represents the technique that has been adopted to attain the proposed and desired, solutions and results of this project.

Major goal was to apprehend the dynamics of cement industry and discover all possible adverse outcomes that this industry imparts on the environment.



3.1. Data and Sample Collection

The most common types of crude rock used in the manufacturing of cement be:

- CaCO3 (materials the bulk of the lime)
- Clay, marl or shale (provisions the volume of the silica, alumina and ferric oxide)
- Further additional resources for instance ironstone to attain the preferred mass symphony residue/pulverized fuel ash (PFA), or sand, fly ash
- The third important thing which we our project is based on Is Coal Slurry waste.

Crude materials are extricated from the quarry, at that point squashed and position as important to give well objects for mixing. The greater part of the substance is typically ground better than ninety microns - the distinction is regularly communicated as the rate held on a ninety micron sieve.

On one occasion the crude resources are pulverized well adequate, they may be merged in the extent needed to make cinder of the preferred concerto.

The combined rare resources are accumulated in a silo prior to being nourished into the oven/kiln. The storage tower stocks numerous days' quantity of substance to offer a cushion towards any glitches inside the delivery of crude substance as of the pit.

In fact, a cement maker can contain nearly total manage over cinder composition by mixing crude resources of diverse masterpiece to deliver the required product. In reality, in any case, cinder symphony is generally decided by the masterpiece of the close by accessible crude resources that make up the volume of the crude feast.

Advantageous resources are utilized to change the arrangement of the crude feast however outlay and accessibility are probably going to decide the degree to which they be utilized.

3.2. Sample Collection

3.2.1. CaCO3

CaCO3 is a sedimentary rock composed specially of mineral calcite (CaCO3). The sandstone's ecological sharing in Pakistan's stratigraphy have higher Indus sink, inferior Indus sink, Peshawar sink, Attock-Cherat choice, Karakoram, Baluchistan, Axial strap, Khyber Agency, Kohistan Island Arc and Hazara Basin.

CaCO3 for askari cement was imported from different regions of Pakistan.

CaCO3 contain all the minerals like CaO, MgO, SiO2, Al2O3, Fe2O3 and Sulphur.


CaCO3 Rocks

3.2.2. CLAY

Clay crude materials are utilized to create the cement clinker as a supplement altering of a furnace input. The essential compound of a furnace input are carbonate rocks: $CaCO_3$s and marls. The ideal amount of $CaCO_3$ in a crude material for the clinker heating is 75-80%. Within the case when the composition of the fundamental crude material varies from these values, different mineral increases are utilized. Clay crude materials decrease the $CaCO_3$ amount and increment the amount of SiO_2, Al_2O_3 and Fe_2O_3.

As per the order utilized in a cement industry, clay crude materials are able to the low crude materials gathering. Law crude objects include less than forty two percent Calcium oxide (less than seventy five percent calcium carbonate), typical crude materials have forty two to forty five percent Calcium oxide (seventy five to eighty percent calcium carbonate) and soaring crude substance have greater than forty five percent Calcium oxide (greater than eighty percent calcium carbonate).

3.2.3. COAL SLURRY

Coal slurry is the byproduct that's left when activities like Quarrying and washing of coal is achieved at or out of doors of the Quarrying field.

Coal slurry is produced as a byproduct and as a rule kept at the location in both liquid as well as solid state. Coal slurry is the blend of coal, clay and all other particles that are straightforwardly or in a roundabout way portion of cement production.

This coal slurry test was taken from Dar e Adam Khel coal mine and after that transported to the Askari cement Wah Cantt. 1 kg substance was isolated for testing reason.

ASKARI CEMENT WAH CANTT (PLANT)

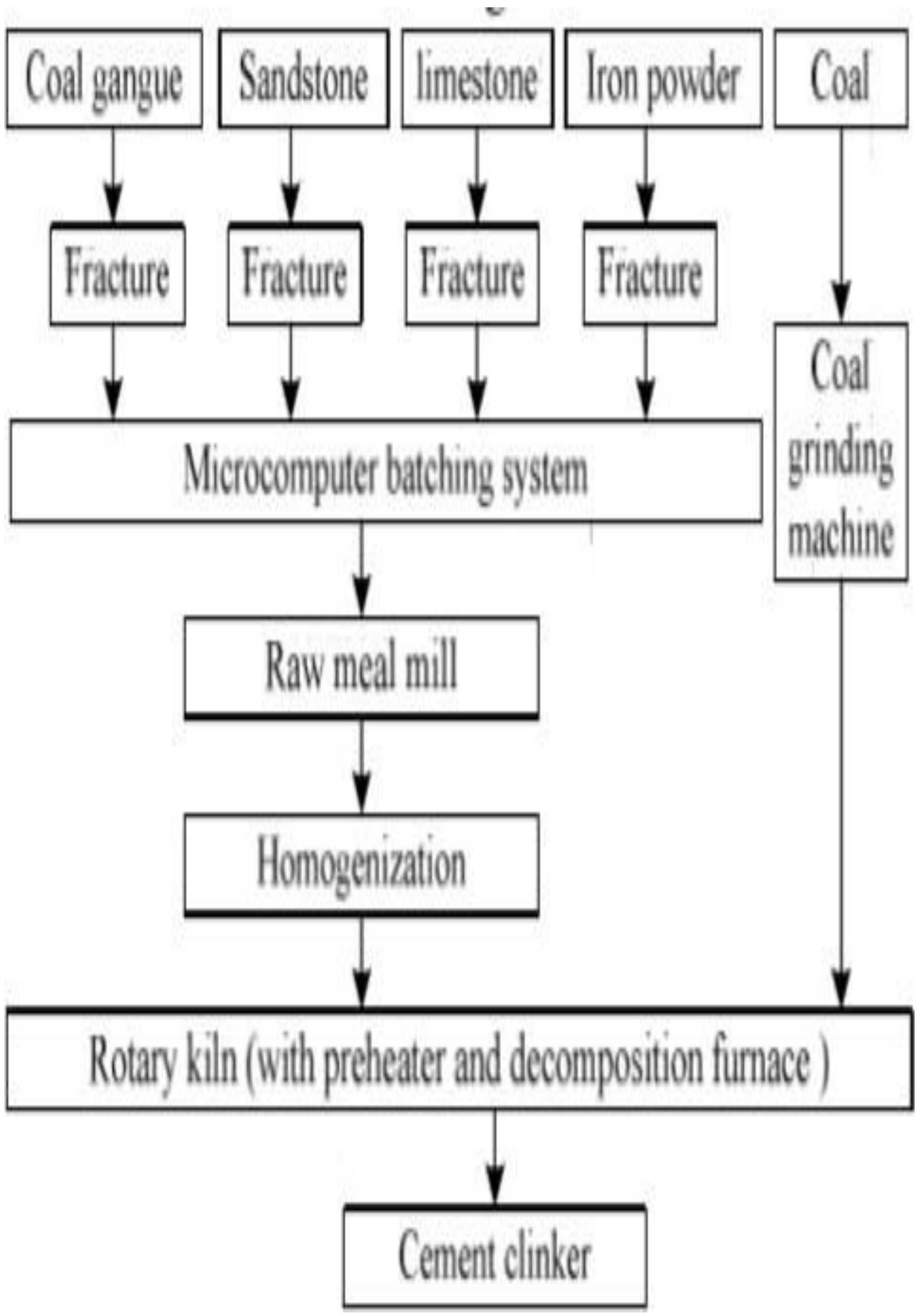
3.3. Sample Testing

Testing of coal slurry squander was carried out in PCSIR Lahore (Pakistan Board of Logical and mechanical Investigate). Test was sent there for the Composition and examination test of the coal slurry to discover out my critical variables like Sulfur substance, mugginess carbon substance and cinder etc.

3.4. Composition Analysis

Industrial scale generation of cement requires chemical composition. Till presently as it were $CaCO_3$ and clay is included where $CaCO_3$ was 75% and clay was roughly 25%.

Presently coal slurry squander will be third constituent and its esteem can extend from 1-5% but here we'll take it till 3%. So, test will be conducted at 1% ,2% and 3% by weight to induce conceivable favorable result.



Coal gangue
Sandstone
limestone
Iron powder
Coal
Fracture
Fracture
Fracture
Fracture
Coal grinding machine
Microcomputer batching system
Raw meal mill
Homogenization
Rotary kiln (with preheater and decomposition furnace)
Cement clinker

3.5. Cement Manufacturing Processes

Stage 1: Extraction of raw material

The cement production begins from the removal of crude resources that are utilized in production of cement, primarily granite and clays. The sandstone is obtained as of unlock spread excavates later than bore and explosions and stacked against dumpers which convey the resources plus empty into containers of sandstone grinders. The soils are unearthed as of unbolt shed excavates and stacked on top of dumpers that convey the resources and empty keen on unlock courtyard capacity. At that point it is elated by means of transportation and emptied into the hopper of a soil grinder. They are 3 sorts of soil utilized in cement construction, specifically silty soil, Zafarana soil, and Kaolin.

Further crude resources are utilized to manage the oven/kiln nourish blend plan, specifically sand, and crude iron. The sand plus crude iron are elated as of around the stand (from distinctive providers) by trucks and emptied into open yard heaps, known as sand in addition to crude iron heaps.

Stage 2: Crushing, milling:

$CaCO_3$ is broken down in the mill known as the baking mill and then mixed with sludge in the next mill known as the beater mill, reducing the molecular estimate to less than 50 mm. The raw alloys ($CaCO_3$ 70%, soil 27% (1-3% coal dirt)), which are released, are moved on the conveyor belt and transported to the analyzer of bulk material. The raw mix is transferred to a circular volume called the raw mix volume. Applicants then pull the mixture out of the store again and send it to a pretreatment container called $CaCO_3$ Bin for peeling.

Another raw material used in the manufacture of cement, known as additives, are pure iron ore, limestone and sand. The ultra-pure $CaCO_3$ is crushed in isolation in the jaw crusher and then crushed in an auxiliary crusher to reduce movement and pass it through the entire 50 mm sieve.

At this point, they are stacked with a CaCO3 label in the long storage component known as the CaCO3 storage style. Ultimately, the retriever directed CaCO3 through the supply and sent it to fire in a raw filter room called CaCO3 Bin.

Stage 3: Mixing of raw material after crushing:

Raw high-quality CaCO3 alloys, sand and iron ores are coated in ore plants such as their cans, windmills, for ventilation and for pounding the well. Raw mills have two chambers, to be precise isolated from the membrane, and a hollow and crushing hall. Hot gases (preheater / oven frame) are preheated in the grinder and used for drying in dry plants. At this point, material which is in process of drying, is moved to round chamber of the shredder to shred the borehole. The cracker basket has a certain amount of ball load on a certain scale from thirty millimeter to ninety millimeters. The hot gas and high-speed materials business promote a practitioner who separates good and raw products. The last part is to rebuild connection by delivering channel of process via air slide. Fine materials and hot gas enter a multi-faceted "storm" to separate gases and fine materials.

The hot gas and high-speed materials business promote a practitioner who separates good and raw products. The last part is t rebuild connection by delivering channel of process via air slide. Fine materials and hot gas enter a multi-faceted "storm" to separate gases and fine materials. Multiple storms provide the fine material known as raw product, and then this raw product is passed through the air slide to be elated which is known as aeropoly. Unusually well-heated materials cause hot gases to enter the ESP to isolate microscopic material for example gases. The fine materials called electrostatic divider dust or preheater dust comprises of fed and filters into alternating transporting belts and now fine product is mixed. Inside the airlift, the rare product is lifted into the air by the compressed air in the warehouse and then placed in a fixed tower of storage. The rare products that are extracted as warehouses and are now known as oven smokers are called poldos for the treatment of Peru with the air lifter.

Stage 4: Preheating and cooling of raw material (clinker formation)

Cement sand is made by spreading Peru in the kiln. The frame of the heating furnace frame consists of a 5-stage, multi-stage preheater, a fuel box, an ascending channel, a rotary kiln and a cooled grinder. Inside the oven, the oven is fed with a hot floor, which is delivered in a burning basket with a volcano. Nowadays, the preheated kiln / kiln is roasted in the combustion basket and in the lifting channel and then in the rotary kiln to produce clinker of C_3S, C_3A, C_2S and C_4AF. The most common source of heat is ordinary coal. The fuel is used to provide the heat needed to convert the product that is fed to the oven into a clinker. The release of a hot oven-like condenser is on the mill cooler to cool down to about 120 ° C from about 1350 or 1450 ° C. Inside the coolant, the amount of cooling air is extracted from the atmosphere by special fans, which are cooled by the atmosphere and excited in the coolant rooms and cause problems in the coolant layer and a soft bench bed. the autumn. The coolant drain tray remains frozen on the conveyor belt and is connected to the coolant storage location. The remaining ball grinding surface is taken as a cement ball mill shell for cementing the cement ball. The secondary and turbulent air, obtained from warm air obtained from a cooler, which is burned individually in a rotary kiln and a combustion chamber.

Stage 5: Grinding of cement

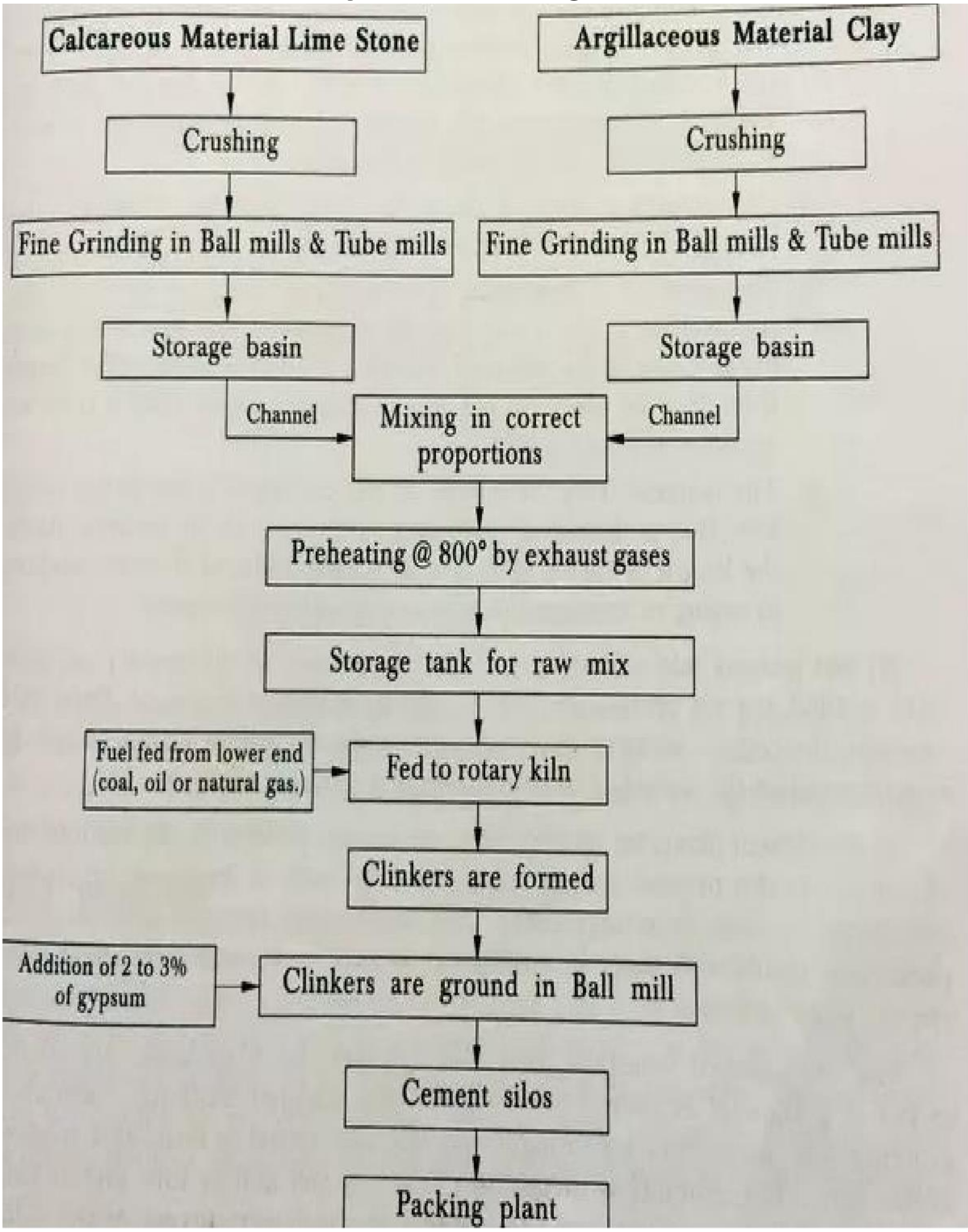
Ashes and gypsum made of OPC and CaCO3 for CaCO3 cement and slag cement are extracted as individual containers and transported to strong factories. The ball mill crushes the product well with two tips, especially in the primary and secondary part. The specified amount of induced sphere in two chambers ranges from 17 mm to 90 mm. The mill starts at a container lift that delivers the product to a separator that completely separates the raw materials. The last male is delivered for reorganization in the grinding bay and at the same time the final component is placed in the solid cells.

Stage 6: Storage and transportation:

Silos Cement is then moved to programmable electronic packaging machines where they are packed and shipped in 50 kg bags.

Cement industrialized procedure Flow Chart

Systematic diagram



Chapter 4
Result and Discussion

So changing the composition of cement as addition of coal slurry is technically viable and for this number of factors are considered. Consequently, some cement guidelines like silica proportion (SR), aluminum proportion (AR) and lime saturation factor (LSF) are estimated to decide a material reliability for utilizing as cement crude material. If the value of SR is high then it implies that more calcium silicates, however low quantity of aluminate and ferrite exist in the clinker. Additionally, high SR causes trouble in combustion of clinker, utilizing high measure of fuel, trouble in sintering and diminishing in cement resistance. Low SR determines effectively sintering of raw meal, and afterward quick-resisting and effortlessly solidified cement can be created. SR is normally required in the scope of 2.0 and 3.0. AR is legitimately connected with clinker heat. Low AR supplies a decrease in clinkering heat and furthermore fuel use. Along these lines, AR estimation of raw meal is required in the middle of 1.5 - 2.5. Likewise, if the value of AR increases it means there will high amount of aluminate and less quantity of ferrite. High AR causes quick-freeze and high resistance cement creation. Lime saturation factor is an amount of Calcium oxide to the next 3 oxides (SiO_2, Al_2O_3 and Fe_2O_3); additionally, it controls the alite and belite proportion in the clinker. Increasing in LSF causes higher extent of alite to belite, additionally, it is a significant boundary to quantify raw meal of Portland concrete clinker and it is very identified with SR and AR. LSF values in the clinkers is normally in the middle of 0.92 – 0.98; be that as it may, LSF estimations of certain locales in the clinker can be a little underneath or somewhat above due to blending of crude materials is never impeccable in the training. The LSF amounts higher than 1.0 is implies that free lime presents in the clinker.

4.1 GENERAL CHARACTERISTICS AND PROPERTIES

Coal slurry waste was included 1 wt. %, 2 wt. % and 3 wt. % sums into the cement composition. The chemical composition of cement and coal slurry waste for the Portland cement clinker creation, mineralogical arrangements and physical properties are given in the accompanying tables separately.

Chemical composition of Raw materials (wt.%)

COMPOUND	RAW MATERIAL (%)	COAL SLURRY WASTE (%)
SiO_2	12.96	42.7
Al_2O_3	3.38	12.8
Fe_2O_3	2.13	5.2
CaO	42.90	1.5
MgO	1.22	3.1
Na_2O	0.26	0.2
K_2O	0.45	1.4
TiO_2	0.25	0.5
SO_3	0.03	2.71
P_2O_5	0.07	0.5
MnO	0.0395	0.08
Cr_2O_3	0.0241	0.071
Cl	0.0111	0.022
LOI	35.51	30.31
HUMIDITY (%)	0.51	4.79
$CaCO_3$(%)	77.2	2.79

Mineralogical Compositions of Raw Materials

RAW MATERAIL	COAL SLURRY WASTE
CHLORITE, $(Mg, Al, Fe)_6(Si, Al)_4O_{10}(OH)_8$	CLINOCHLORE, $(Mg, Fe)_6(Si, Al)_4O_{10}(OH)_8$
MUSCOVITE, $(K, Na) Al_2(Si, Al)_4O_{10}(OH)_2$	ILLITE, $(K, H_3O) Al_2Si_3AlO_{10}(OH)_2$
DOLOMITE, $CaMg (CO_3)_2$	MAGNESITE, $MgCO_3$
QUARTZ, SiO_2	KAOLINITE, $Al_2Si_2O_5(OH)_4$
FELDSPAR, $(K, Na) AlSiO_3O_8$	DOLOMITE, $CaMg (CO_3)_2$
CALCITE, $CaCO_3$	QUARTZ, SiO_2
	ANHYDRITE, $CaSO_4$

Grain size distribution of Raw materials

Sieve Opening Size(micrometer)	Acceptable Ranges Of % Passing By Mass	
	Raw Meal	Coal Slurry Waste
416	98.391	100
200	89.971	98.90
125	79.991	97.740
90	74.611	95.550
63	66.891	91.620
53	64.551	90
45	62.391	87.71
32	56.682	79.760
11	44.452	50.1
2	15.153	10.3

4.2 INDUSTRIAL SCALE CLINKER PRODUCTION

Industrial scale clinker creation contemplates are completed in Askari concrete Wah Cantt. Askari Cement Ltd is one of the main producers of Cement in Pakistan. It started in 1921 and since then it has successfully moved and won the trust of many people around the world.

Askari cement meets the needs of the world of housing and infrastructure. It is driven by the needs of its customers, investors, neighborhood networks and engineers. We breathe life into material life and extract assets from Earth's resources.

For now Askari Cement consists of two plants which are active, one is situated in Wah, Punjab Pakistan and the second one is in Nizampur (Khyber Pakhtunkhwa). Both plants produces limit of 9,345 tons for each day.

Chemical composition at Askari cement Wah cantt

Compound	Limestone (%)	Shale (%)	Sand (%)	Bauxite (%)	Iron Source Mix (%)	Raw Materials Mix (%)
SiO_2	3.16	44.40	82.57	10.30	28.4	15.58
Al_2O_3	0.65	11.17	5.53	50.09	5.71	3.66
Fe_2O_3	0.29	9.93	5.10	24.02	54.63	1.812
CaO	53.15	15.20	0.58	3.0313	0.701	42.242
MgO	0.33	6.101	0.283	0.6532	0.571	1.323
SO_3	0.09	0.142	0.042	0.282	0.281	0.0294
Cl^-	0.0062	0.0042	0.013	0.0012	0.0022	0.0013
Na_2O	0.0143	1.464	0.0324	0	0.042	0.132
K_20	0.4321	0.305	0.642	0.442	0.303	0.442
LOI	41.93	10.85	5.12	10.22	9.44	34.62
TOTAL	**100.22**	**99.5043**	**99.8732**	**99.8212**	**100.032**	**99.813**
H_20	2.43	6.5	11.52	4.72	13.6	5.6

After chemical composition assurance of crude materials, industrial raw meal and clinker creations were done, separately.

4.3 RAW MEAL PRODUCTION

In raw meal production, limestone and coal slurry waste were used in average percentages (1-3%) as given in table.

LIMESTONE + CLAY MIX (%)	LIMESTONE (%)	FELDSPAR (%)	IRON SOURCE (%)	COAL SLURRY WASTE (%)
80.2	15.58	2.4	0.71	1.00
79.20	15.58	2.40	0.72	2.10
78.84	15.24	2.31	0.56	3.05

Factor of saturation for lime (LSF)

The factor of saturation for lime is a proportion of calcium oxide to the next 3 main different oxides. It is determined by equation

$$LSF = \frac{CaO}{2.8(SiO2)} + 1.18(AL2O3) + 0.65(FE2O3)$$

Mostly it is taken in percentage so multiplied with 100.

Lime saturation factor depicts the amount of elite in the clinker of Portland cement. Greater the value greater will be the amount of elite in the clinker and normally it has value of 92-98%.

Amount higher than 1 or 100% shows the presence of free lime which depicts that every elite has been converted to belite and now lime is unable to find elite to react with.

It is common understanding that human and systemic error exist and all the raw material is not mixed accordingly thus lime saturation factor it also kept intentionally high to be on safe side. Likewise, this means that in order to change all intentions and goals to unite all individuals, LSF needs a modest 1.0.

1 WT. % COAL SLURRY WASTE

$$LSF = \frac{CaO}{2.8(SiO2) + 1.18(AL2O3) + 0.65(FE2O3)}$$

LSF = (43.13)/2.8(12.76) + 1.18(3.4) + 0.65(2.24)

LSF = 104.65

2 WT. % COAL SLURRY WASTE

$$LSF = \frac{CaO}{2.8(SiO2) + 1.18(AL2O3) + 0.65(FE2O3)}$$

LSF = 107.8

3 WT. % COAL SLURRY WASTE

LSF= (CaO)/2.8(SiO2) +1.18(AL2O3) +0.65(Fe2O3)

LSF = (42.81)/2.8(12.72) + 1.18(3.07) + 0.65(2.29)

LSF = 106.1

ASKARI CEMENT WAH CANTT RAW MEAL

LSF= (CaO)/2.8(SiO2) +1.18(AL2O3) +0.65(Fe2O3)

LSF = (42.81)/2.8(12.72) + 1.18(3.07) + 0.65(2.08)

LSF = 105.46

Henceforth the quantities are similar with the askari cement raw meal value along these lines there is practically nothing, or you can say no impact on LSF while including coal slurry squander.

4.4 SILICA RATIO (SR)

The term Silica ratio is also called as silica modulus, and it is stated as:

$$SR = SiO_2 \div (AL_2O_3 + FE_2O_3)$$

Greater amount of silica contents indicates the presence of high calcium silicate and low amount of ferrite and aluminum. Reduces stress and cement resistance. Low SR meters can be used to sintering raw food effectively, thus providing instant resistance and easily reinforced concrete. SR is usually in the range of 2.0 and 3.0.

1 WT. % COAL SLURRY WASTE

$SR = SiO_2 \div (AL_2O_3 + FE_2O_3)$

SR = 12.78/ (3.4+2.24)

SR = 2.26

2 WT. % COAL SLURRY WASTE

$SR = SiO_2 \div (AL_2O_3 + FE_2O_3)$

SR = 12.38/ (3.17+2.28)

SR = 2.27

3 WT. % COAL SLURRY WASTE

$SR = SiO2 \div (AL2O3 + FE2O3)$

SR = 12.56/ (3.31+2.29)

SR = 2.24

Askari cement wah cantt raw meal

$SR = SiO2 \div (AL2O3 + FE2O3)$

SR = 12.72/ (3.07+2.09)

SR = 2.46

Consequently, the qualities are equivalent with the askari cement raw meal value therefore there is practically nothing, or you can say no impact on SR while including coal slurry waste.

4.5 Ratio of Aluminum (AR)

This ratio of alumina is defined as:

AR=(Al_2O_3/(Fe_2O_3)

The former decides relatively on the expected ferrite lighting and clinker stage.

The increased AR clinker (which has been configured in addition to A / F for some time) means that the clinker will be more aluminum and less ferrite. Augmented reality is associated with clinker heat. Low augmented reality provides radiant heat and reduces fuel consumption. As a result, the AR value for raw food should be between 1.5-2.5. Likewise, an increased AR means that clinker contains more aluminum and less frit. High AR causes instant freezing and high resistance to cement. In typical Portland slag, AR, as a rule, is anywhere between 1 and 4.

1 WT. % COAL SLURRY WASTE

AR=(Al_2O_3/(Fe_2O_3)

AR= (3.4/2.24)

AR = 1.52

2 WT. % COAL SLURRY WASTE

AR=(Al_2O_3/(Fe_2O_3)

AR= (3.17/2.28)

AR = 1.39

3 WT. % COAL SLURRY WASTE

AR=(Al_2O_3/(Fe_2O_3)

AR= (3.31/2.29)

AR = 1.45

Askari cement wah cantt raw meal

AR=(Al_2O_3/(Fe_2O_3)

AR= (3.07/2.09)

AR = 1.47

Henceforth the quantities are practically identical with the askari cement raw meal value consequently there is practically nothing, or you can say no impact on AR while including coal slurry squander.

Compound	Raw Meal			Askari cement wah cantt Factory Raw Meal (%)
	1 wt. % CSW	**2 wt. % CSW**	**3 wt. % CSW**	
Al_2O_3	3.4	3.17	3.31	3.07
CaO	43.13	42.99	43.02	42.81
CL^-	0.007	0.007	0.006	0.007
Fe_2O_3	2.24	2.28	2.29	2.09
K_2O	0.41	0.45	0.45	0.47
MgO	1.29	1.53	1.28	1.55
Na_2O	0.16	0.28	0.2	0.26
SiO_2	12.76	12.38	12.56	12.72
SO_3	0.34	0.29	0.32	0.14
LOI	35.36	35.81	35.7	35.9
TOTAL	**99.037**	**99.17**	**99.14**	**99.01**
Lime Saturation Factor (LSF)	104.65	107.8	106.1	105.461
Silica Ratio (SR)	2.262	2.27	2.24	2.462
Alumina Ratio (AR)	1.522	1.392	1.45	1.471

Subsequently each of the three boundaries LSF, AR and SR are unaffected by the addition of coal slurry waste in the Portland cement which delineates that the quality and solidifying properties of Portland concrete stay undisturbed by the addition of coal slurry waste. Thus, one of the significant analysis that if we include coal slurry in Portland cement or not the cement will show indistinguishable properties from appeared by past raw meal.

4.6 CHEMICAL AND PHSYICAL ANAYLYSIS OF CSW CONTAING CLINKER

With these messages, when we summarize all our discoveries and search under the table, we get the result of all the chemical and physical examination of the coal waste that contains clinker.

Comparing with Portland cement of Askari cement

Compound	**Clinker**			**CIMSA Inc. Factory Values (%)**
	1 wt. % CSW	**2 wt. % CSW**	**3 wt. % CSW**	
CaO	65.50	65.67	65.74	65.94
SiO_2	21.25	20.91	21.21	21.23
Al_2O_3	5.63	5.39	5.46	5.25
Fe_2O_3	3.40	3.36	3.40	3.44
MgO	2.00	2.49	1.96	2.18
K_2O	0.63	0.62	0.65	0.66
Cl	0.006	0.007	0.005	0.008
Na_2O	0.25	0.38	0.32	0.28
TiO_2	0.15	0.20	0.20	
SO_3	1.08	0.81	1.07	1.00
Undefined	0.10	0.16	0.19	

TOTAL	**99.999**	**99.84**	**100.0**	**99.99**
LSF	95.811	97.93	96.65	97.401
Silica Ratio (SR)	2.352	2.393	2.395	2.442
Alumina Ratio (AR)	1.601	1.62	1.6153	1.534
Free lime	1.933	2.341	2.103	1.654
Density (g/l)	1230	1230	1210	1250

4.7 STRENTH FACTORS

The components that determine the strength of concrete are C3S, C2S, C3A and C4AF. They measure quality and turn into many types of concrete.

The purpose of the clinker structure was to move from the early stages of the real Portland clinker to the controversial stages. Using Bog calculations, the C3S, C2S, C3A, and C4AF measurements were solved by ASTM C 150-92. The basic steps are listed in the table with their short words. In the construction of Portland cement, stage C3S is the main compound.

Abbreviation	**Compound**	**Formula**
C_3S (Alite)	Tricalcium Silicate	$3CaO.SiO_2$
C_2S (Belite)	Dicalcium Silicate	$2CaO.SiO_2$
C_3A (Aluminate)	Tricalcium aluminate	$3Ca.Al_2O_3$
C_4AF (Ferrite)	Tetracalcium aluminoferrite	$4CaO.Al_2O_3.Fe_2O_3$

The main phases of coal slurry waste containing clinkers are

Main phases	Clinker			Askari cement Wah CanttFactory Values (%)
	1 wt. % CSW	2 wt. % CSW	3 wt. % CSW	
C_3S	57.53	57.72	64.76	55-65
C_2S	19.80	16.43	11.98	11-20
C_3A	8.16	8.6	8.72	7-9
C_4AF	10.37	10.25	10.36	10-15

- C3S increases strength
- C2S increases hardness
- C3A increases setting time
- C4AF for process indication

All qualities are inside the range, estimations of 3% CSW is more prominent demonstrating that the strength properties and attributes of Portland cement are higher than show in this manner quality is heightened.

4.8 Burnability index

The rate of burning for Portland ordinary cement creation can be characterized as the rate by which free calcium oxide (free CaO) responds in the oven with silicon, aluminum and iron oxide. The burnability record (B.I) is determined by the Eqs.

Burnability Index (B.I) = 100*1/3((free Cao at 1400ºC/3.6) + (free Cao at 1450ºC/2.6) + (free Cao at 1500ºC/1.6))

Calculated burnability index was calculated according to the given values. If,

B.I. < 83 Fast and easy burnability

83 < B.I. < 120 moderate or normal burnability

B.I. > 120 Hard and slow burnability

To see the impact of CSW consolidation, the rate of burning of 3% wt. blends were analyzed. The primary blend (reference raw meal) depended on a right now utilized at the large scale in cement creation. The second and the third blends are set up by utilizing 2 wt. % and 3 wt. % CSW expansion to the reference raw meal.

Burnability is as shown below and the expansion of 2 wt. % and 3 wt. % CSW t make the burnability faster and easier than standard cement od Askari cement wahh cantt.

Burnability test results

	Raw Meal (reference) Askari Cement Wah Cantt	Coal Slurry Waste	
Raw meal (%)	100	98	97
CSW (%)	--	2	3
1400’C	3.70	1.84	1.55
Free CaO 1450’C	2.97	1.70	1.43
1500’C	2.16	1.44	0.83
B.I.	117.34	68.83	49.98
Result	Normal Burnability	Easy Burnability	Easy Burnability

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSIONS

From the economic scale production of Portland cement, it could be concluded that the addition of coal slurry waste taken from DAR E ADAM KHEL KPK, in the generation of
clinker of Askari cement is unfastened from any major predominant type of environmental effect.
Some of the primary conclusions are listed as under.

- Coal slurry waste can be used as raw fabric in cement manufacturing
- Addition of coal slurry in clinker manufacturing via 2 wt. % and 3 wt. % helps within the burning procedure of cement thus results more economical production of Portland cement.
- By detail evaluation of chemical composition of clinker formed with the aid of coal slurry waste suggests that addition up to 3 wt. % allowable section composition and all main levels are comparable with Askari Portland cement clinker.
- This addition has predominant effects on fee of production of cement. As smooth burning will

consume less fuel and decrease the fuel requirement and
economical the method will be.

• Coal slurry waste can't be used if the humidity and volatile nature is sizable high. First it has to be in the range, and it can be done by hydration of coal slurry waste.

• High unstable nature ought of coal slurry taken from mining fields to be considered thoroughly due to the fact it restricts the use of coal slurry in cement as it reduces the clinker production potential.

5.2 RECOMMENDATIONS

- Similar study and analysis of coal slurry of other mines should be conducted and used in cement industry.
- More environmental waste like pozzolan present in Murree hills should also be studied as it can be used as alternative material.
- Monitoring and controlling devices for Gases emission should be installed in cement plants to control and purify the gases emitted through these plants.
- Testing on the concrete block and mortar should be done for further confirmation of this experiment.

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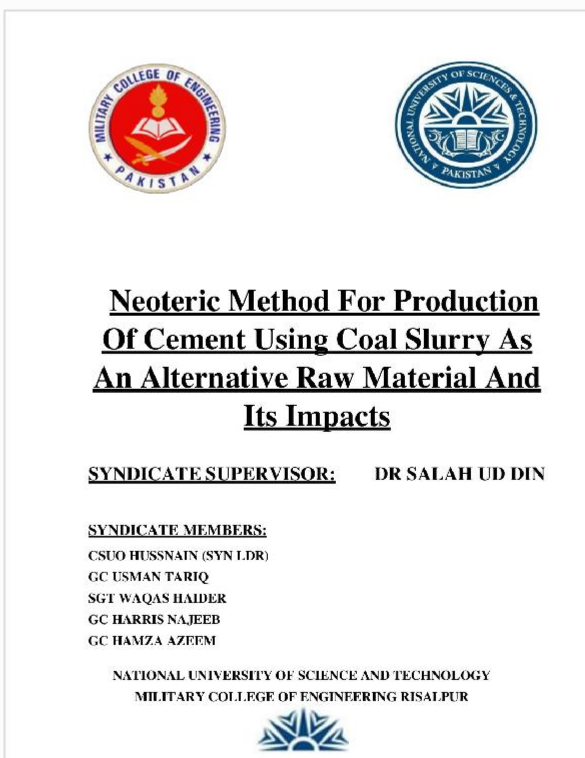

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