POKHARA UNIVERSITY

NEPAL ENGINEERING COLLEGE

A PROPOSAL ON

"QUALITY ASSESSMENT OF CEMENTS MANUFACTURED IN NEPAL"

Submitted by:

Preshina Bartaula (020-021)

Rabin Giri (020-022)

Rakshya Laxmi Sharma (020-023)

Ranjan Shrestha (020-024)

Submitted to:

Department of Civil Engineering

ACKNOWLEDGEMENT

We, the group members would like to express our special thanks of gratitude to our teachers, the Department of Civil Engineering, Nepal Engineering College as well as to Pokhara University who gave us this golden opportunity to undertake this project. This opportunity has helped us to be involved in research and it helped us to gain more knowledge. We learned about so many things which will be useful for us in future.

This research for the project is a lesson to learn for the development of our self-skills and analysis. Furthermore, we would like to express our sincere gratitude to our Project Supervisor **Associate Prof. Dibyashree Lohani** for guiding us for the research and a platform where we can express our findings.

Thank you,

Preshina Bartaula (020-021)

Rabin Giri (020-022)

Rakshya Laxmi Sharma (020-023)

Ranjan Shrestha (020-024)

Table of Contents

ACKNOWLEDGEMENT ..... **II**
LIST OF FIGURES ..... **IV**
LIST OF TABLES ..... **V**
1. INTRODUCTION **1**
1.1 STATEMENT OF PROBLEM **1**
1.2 OBJECTIVES **2**
1.3 SCOPE OF WORK **2**
1.4 SIGNIFICANCE OF STUDY **3**
1.5 LIMITATIONS **3**
CHAPTER 2 ..... **4**
2.1 LITERATURE REVIEW **4**
CHAPTER 3 ..... **11**
3.1 METHODOLOGY **11**
3.1.1 DATA COLLECTION **12**
3.1.2 Primary Data **12**
CHAPTER 4 ..... **15**
4.1 WORK SCHEDULE **15**
EXPECTED OUTCOME **16**
References **17**

LIST OF FIGURES

Figure 1: Flow diagram of manufacture process of cement

Figure 2: Manufacture process of cement in an industry

Figure 3: Flowchart of methodology

LIST OF TABLES

Table 1: Physical and chemical properties of cement (Chaudhari, 2018)

Table 2: Work schedule (Gantt Chart)

CHAPTER 1

1. INTRODUCTION

Cement is a crucial construction material in the construction industry. It is used to make a wide variety of structures, from buildings and bridges to roads and sidewalks. Cement is a fine powder made from a mixture of limestone, clay, sand, and iron ore. When this powder is mixed with water; it forms a paste that can be used to bind together small stones or gravel. Once this mixture dries, it hardens into a solid, durable material known as concrete.

In the context of Nepal, cement is an important building material for both residential and commercial construction. Nepal has a large construction industry due to the country's ongoing development and rebuilding efforts following the 2015 earthquake. The demand for cement in Nepal has been increasing over the years and the country imports a significant amount of cement to meet the demand. The quality of cement produced in Nepal has been a concern in the past. However, the government has been working to improve the quality of cement by implementing stricter regulations and quality control measures. The government has also been encouraging the use of alternative building materials. The purpose of this proposal is to assess the quality of cements manufactured in Nepal and to identify any areas where improvements can be made. The proposal will focus on evaluating the chemical and physical properties of the cements, as well as their performance in various applications. The proposed solution is to conduct a thorough analysis of the cements and to provide recommendations for improving the quality of the cements. This assessment will help to ensure that the cements manufactured in Nepal meet the necessary quality standards and to improve the quality of cements for the benefit of the construction industry in Nepal.

1.1 STATEMENT OF PROBLEM

The construction industry in Nepal relies heavily on cement as a vital building material, and it is essential that the cements used meet the necessary quality standards. However, there have been concerns about the quality of cements manufactured in Nepal, with reports of poor strength, poor durability, and other issues. This has led to a lack of confidence in the quality of cements

manufactured in Nepal and raised concerns about the safety and durability of the structures built with these cements. The problem is that there is a need for a comprehensive assessment of the quality of cements manufactured in Nepal to identify any areas where improvements can be made and to ensure that the cements meet the necessary quality standards. This assessment will help to improve the quality of cements and ensure the safety and durability of the structures built with these cements, benefiting the construction industry and the general population in Nepal.

1.2 OBJECTIVES

The objectives of the proposed quality assessment of cements manufactured in Nepal are as follows:

I. To analyze the samples to determine their chemical and physical properties, including fineness, consistency, initial setting time, soundness, and compressive strength.
II. To evaluate the strength of the cements as concrete and mortar and compare the results within the samples taken.
III. To compare the results with the relevant standards and codes and verify if it meets the standards as claimed by the company or not.

1.3 SCOPE OF WORK

The scope of quality assessment for cements manufactured in Nepal will include various tests to evaluate chemical composition, physical properties, and performance. This will include fineness test, soundness test, compressive strength, and setting time test. The manufacturing process, raw materials, equipment and facilities will also be evaluated to ensure consistent product quality. In addition, quality assessment of cements in Nepal will typically involve an evaluation of the manufacturing process, including the raw materials used, the equipment and facilities, and the quality control measures in place to ensure consistent product quality. The exact scope of quality assessment will depend on the specific regulations and standards in Nepal.

1.4 SIGNIFICANCE OF STUDY

After the completion of the study, the cements manufactured in Nepal will have multiple aspects and will impact various stakeholders in different ways. The study will evaluate the quality of cements, ensuring that they meet relevant standards and regulations and are safe for their intended use. This will help to protect consumers and ensure that they will get the value for their money. Additionally, the study will provide valuable insights into the strengths and weaknesses of the cement manufacturing industry in Nepal, helping manufacturers to produce better-quality cements and increase the competitiveness of the industry. The quality assessment of cements manufactured in Nepal will also help to support the development of high-quality and sustainable infrastructure in the country, as cement is a critical component in the construction of infrastructure, such as buildings, roads, and bridges. Moreover, the study will help to promote the export of these products to other countries, increasing international trade and supporting the country's economy. Overall, the study on the quality assessment of cements manufactured in Nepal will have far-reaching benefits for consumers, the industry, the economy, and the country as a whole.

1.5 LIMITATIONS

There will be some limitations while doing the tests in the laboratory:

I. The room temperature affects the results of the tests and accurate result may not be obtained.
II. The testing machines might have errors which may cause inaccurate readings.
III. Some tests like compressive strength test can be dangerous and require specialized equipment and training. This can increase the risk of accidents and injuries in the lab.
IV. Sample size of cement is very small that the test cannot be generalized due to varying results.

CHAPTER 2

2.1 LITERATURE REVIEW

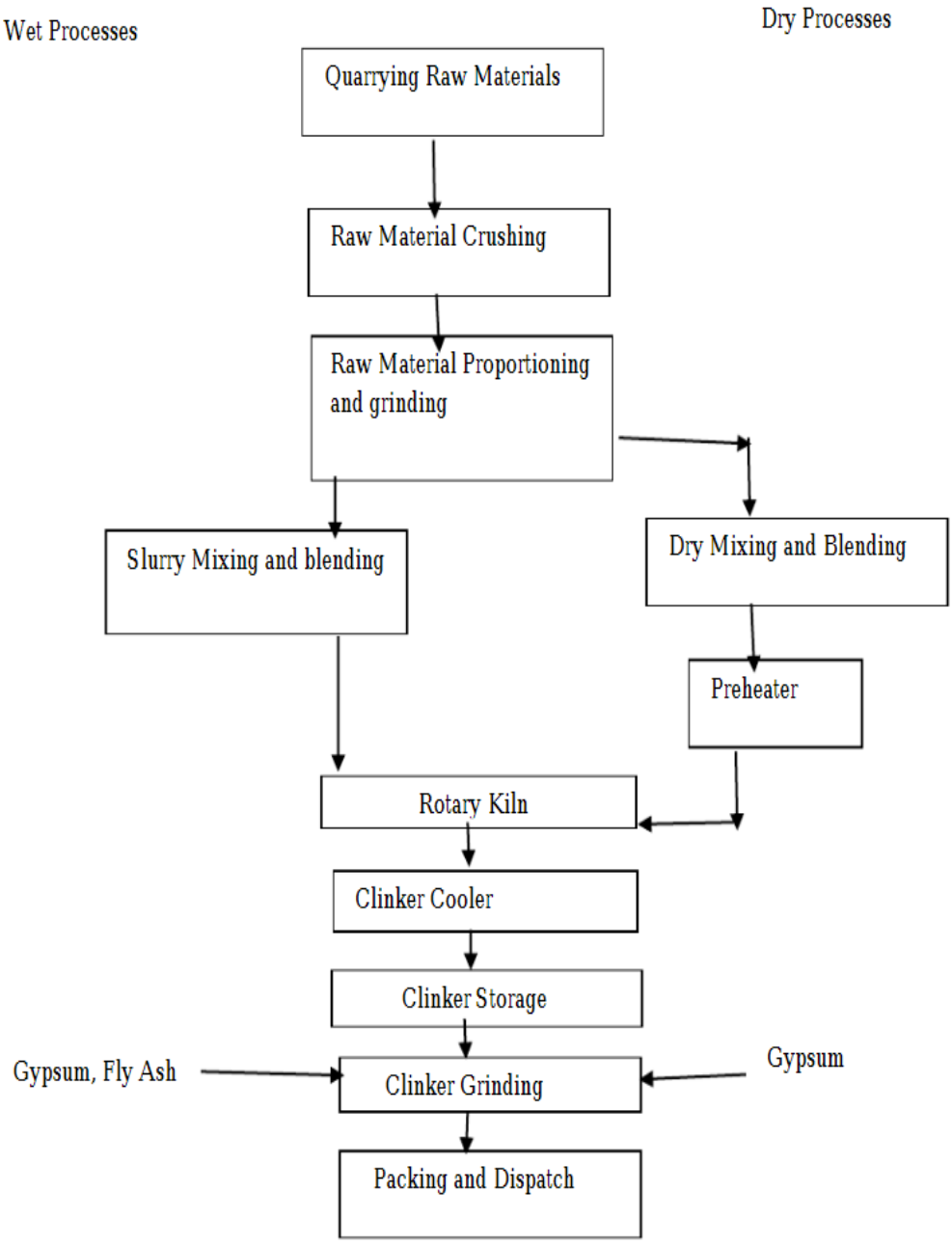


Figure 1: Flow diagram of manufacture process of cement (Mishra & Jha, 2019)

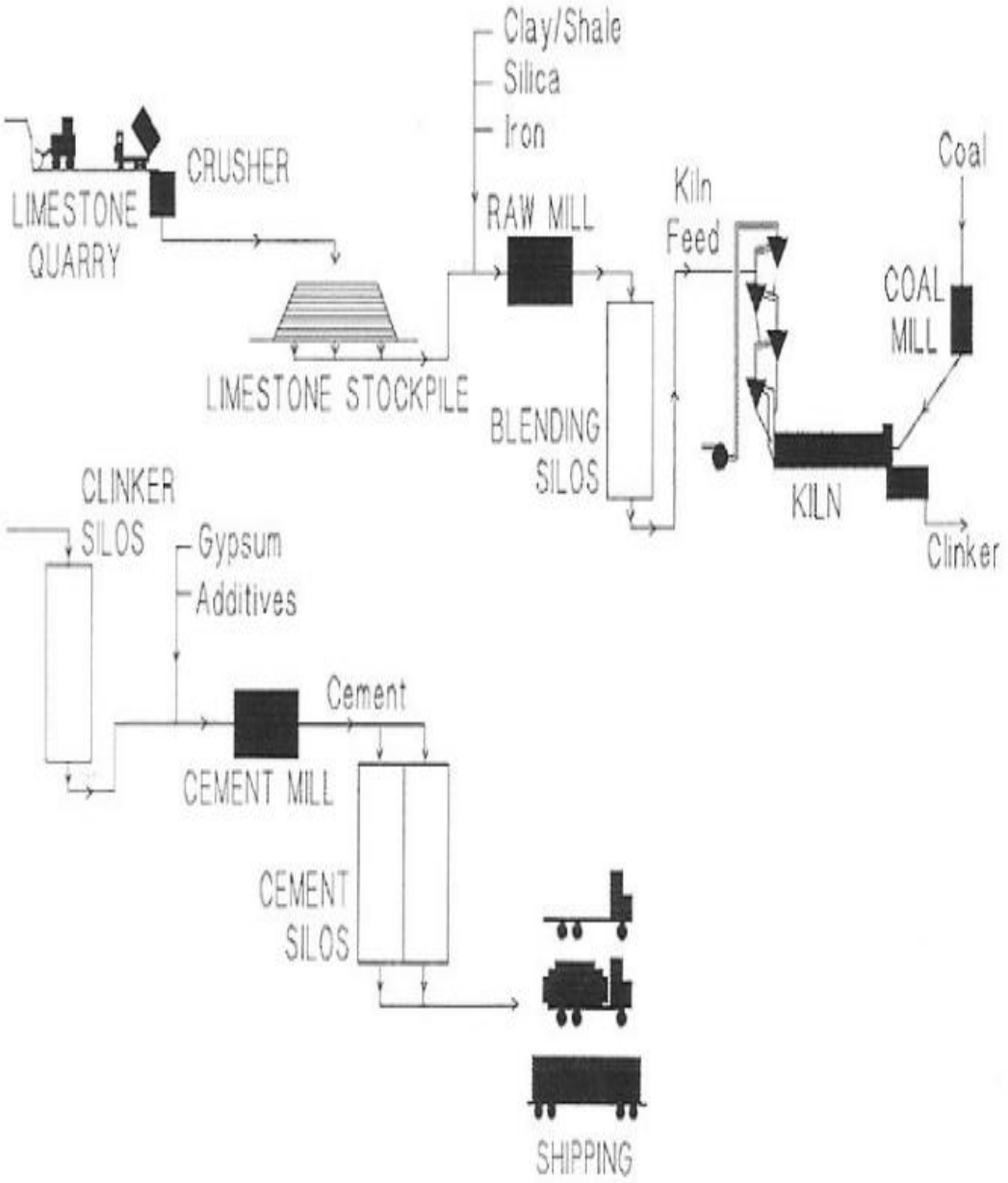


Figure 2: Manufacture process of cement in an industry (Pandey, 2008)

Cement is manufactured from calcareous material, such as limestone or chalk, and of silica and alumina found as clay or shale. Manufacturing consists of grinding the raw materials into very fine powder, mixing them in suitable proportions and burning them in a large rotary kiln at a temperature of about 1400 degree centigrade (Mishra A.K., 2018) when the material melts and partially fuses into clinker. The clinker is cooled and after that it is ground to a fine powder, along with the addition of some gypsum, a resulting the product as the commercial Portland cement used throughout the world. The raw materials can be mixed and ground either in water or in a dry condition; hence giving the names wet and dry process. The mixture is fed into a rotary kiln. The kiln is slightly inclined. The mixture is fed at the upper end while pulverized coal is blown in by an air blast at the lower end of the kiln. When the mixture of raw materials moves down the kiln, it is progressively subjected to higher temperature as a result of which various chemical changes take place along the kiln: First being the water driven off and CO_2 is liberated from calcium carbonate. After Passing through a series of chemical reactions in the kiln, 20 to 30 percent of the dry material becomes liquid, and lime, silica and alumina recombine. (Mishra & Jha, 2019) The compounds are fused into balls of 3 to 25 mm in diameter and is known as clinker. Afterwards, the clinker drops into coolers. The cool clinker, which is very hard, is grinded with gypsum in order to prevent flash setting of the cement. The ground material is cement. The cement can be manufactured by dry process as well as wet process. In wet process, ground raw materials are mixed with water and are converted into slurry before burning in rotary kiln.

Cement is a material having adhesive and cohesive properties enabling it to form good bond with other materials. In concrete, cement is the main constituent which is the only active binding media and the only component scientifically controlled. Cement has the property of setting and hardening by virtue of chemical reactions with water at normal temperature. Ordinary Portland Cement (OPC) is the most common type of cement in widespread use around the world because it is a basic ingredient of concrete and mortar. It is a fine powder produced by grinding Portland cement clinker (more than 90%) (Mishra A.K., 2018), a limited amount of calcium sulphate which controls the set time and up to 5% minor constituents. The OPC or the Ordinary Portland Cement is the most widely produced cement in Nepal. Also due to high consumption of cement, the production is also high which causes the increase in duration between manufacturing and use of the cement on construction work (Banstola Prabin, 2021).Infrastructure being the major indicator of development and the R.C.C structures being the most common, popular, easy and durable method of construction, demand of cement is increasing every year. Over the past few years, cement production has followed an upward

trend in Nepal. Currently, 55 cement industries are in operation with an annual capacity of 15 million metric tons (Bank, N.R., 2021). Cement consumption in different sectors like household, bridges, dams, roads etc. showed increasing trend in cement consumption. Preference of suppliers of cement was not found to be associated with price of cement. Mostly, cement is used as a mortar in masonry, precast pipes and elements, pointing and plastering works and for different type of concreting the structural elements. It is manufactured through a controlled chemical combination of calcium, silicon, aluminum, iron and other ingredients in the required temperature. Chemical composition between the ingredients, their sufficiency and the temperature during its manufacturing process highly influences its consistency of strength development. Thus, the manufacturing process of different cements such as Ordinary Portland Cement (OPC), Pozzolana Portland Cement (PPC) and Portland Slag Cement (PSC) differs from each other as per their property related with their strengths. Based on the property of cement, they are used for different purpose in different places considering the climatic factors that affects the quality of cement (Mishra and Jha, 2019).

Cement is used as a binder or concrete while constructing various types of masonry. Portland cement concrete has clearly emerged as the material of choice for the construction in the world today. This is due to low cost of materials and construction for concrete structure as well as low cost of maintenance. Therefore, much advancement of Concrete technology has occurred depending on (i) the speed of construction (ii) the strength of concrete (iii) the durability of concrete and (iv) the environmental friendliness of industrial material like, fly ash, blast furnace slag, silica fume, metakaolin etc. (P.Ghosh, 2005)

The sieving method is a way to determine the fineness of cement by measuring the particle size distribution of the cement. The method involves passing a sample of cement through a set of sieves of different mesh sizes. A sieve is a device with a mesh or perforated surface that separates larger particles from smaller particles. The sieves used for fineness test of cement are usually made of stainless steel and have distinct size openings, typically ranging from 90 microns to 45 microns. (Mishra & Jha, 2019)

The consistency of cement is a measure of the wetness or plasticity of the cement paste. It is determined by measuring the amount of water required to produce a cement paste of standard consistency. The standard consistency is defined as the water content at which the cement paste can be molded into a ball of cement paste that will retain its shape without breaking or slumping. The Vicat’s apparatus is method that can be used to determine the consistency or initial setting time of

cement. The Vicat's apparatus consists of a cylindrical metal plunger that is inserted into the cement paste at a specific depth. The Vicat's apparatus is used to determine the consistency of cement by measuring the length of plunger dip.

The initial setting time of cement is the time it takes for cement to start solidifying after water has been added to it. The initial setting time test is performed in order to determine the time at which the cement paste can no longer be molded and starts to stiffen. The test is used to ensure that the cement conforms to the specifications set by the Nepal Bureau of Standards and Metrology (NBSM). The initial setting time of cement is typically determined using a device called a Vicat's apparatus. The apparatus consists of a cylindrical metal needle that is inserted into the cement paste at a specific depth. The time is recorded when the needle comes into contact with the bottom of the cement paste and does not penetrate any further.

The compressive strength of cement is a measure of the ability of the cement to withstand loads that tend to compress it. The compressive strength test is typically performed on a cement sample that has been cured for a specific period of time, usually 3, 7, 28 days or longer. In Nepal, the compressive strength test is typically performed using a device called a compression testing machine or a universal testing machine. The machine consists of a loading frame, a loading platen, and a cylindrical specimen mold.

The soundness of cement is determined by measuring its ability to retain its original volume after being subjected to the cycles of expansion and contraction caused by the absorption and loss of moisture.

Grading System of Cement

- 33 grade cement

  33 grade cement has minimum compressive strength of 33 MPa at the end of 28 days of curing. This cement is used for common construction work under normal environment condition. According to Nepal standard (NS: 49:2041) OR Indian standard (IS: 269:1989), strength gaining and hydration is also slow as it gains the strength of 16 MPa in 3 days and 22 MPa in 7 days.

- 43 grade cement

  43 grade cement has minimum compressive strength of 43 MPA at the end of 28 days of curing. It is used to make concrete having a grade between M20 and M30 and is used in plan concrete and plastering work. According to Indian standard (IS: 8112:1989), 23 MPa of strength will be gained in 3 days and 33 MPa of strength in 7 days.

- 53 grade cement

  53 grade cement has minimum compressive strength of 53 MPA at the end of 28 days of curing. The prude of cement is used in making concrete mis above M25 and a mostly used for the structural purpose as in reinforced cement concrete. According to Indian standard (IS: 12269:1987), 27 MPa of strength will be gained in 3 days while 37 MPa of strength will be gained in 7 days.

S.N	Characteristics	As Per 33 Grade (NS: 49:2041)/ (IS: 269:1989)	As Per 43 Grade (IS: 8112:1989)	As Per 53 Grade (IS: 12269:1987)
A.	**Chemical Characteristics**			
1	LSF (Lime Saturation factor)	0.66-1.02	0.66-1.02	0.66-1.02
2	AM (Alumina Modulus)	0.66 (min.)	0.66 (min.)	0.66 (min.)
3	Insoluble residue (% Mass)	2% (max)	2% (max)	2% (max)
4	Magnesia (% Mass)	5% (max)	5% (max)	6% (max)
5	Sulphuric Trioxide (SO3)	3% (max)	3% (max)	3% (max)
6	Total loss on Ignition %	4% (max)	4% (max)	4% (max)
B.	**Physical characteristics**			
1	Specific surface (Cm^2/g)	225 m^2/kg. (min)	225 m^2/kg. (min)	225 m^2/kg. (min)
2	Setting time (minutes)			
a	Initial setting time	Not less than 45 minutes	Not less than 30 minutes	Not less than 30 minutes
b	Final setting time	Not less than 600 minutes	Not less than 600 minutes	Not less than 600 minutes
3	Soundness			
a	By le-chataller (MM)	10mm (max.)	10mm (max.)	10mm (max.)
b	By Auto clave (%)	0.8% (max.)	0.8 %(max.)	0.8 %(max.)
4	Compressive Strength (N/mm2)			
a	072±1 hour; 3 days	16 Mpa (min.)	23 Mpa(min.)	27 Mpa (min.)
b	168 ± 1 hour: 7 days	22 Mpa (min.)	33 Mpa (min.)	37 Mpa (min.)
c	672±4 hours:28 days	33 Mpa (min.)	43 Mpa (min.)	53 Mpa (min.)

(NBC101:1994, 2064), (IS8112:1989, 2005), (IS12269:1987, 1988 as Cited in Mishra and Chaudhar,2018)

Table 1: Physical and chemical properties of cement *(Chaudhari, 2018)*

CHAPTER 3

3.1 METHODOLOGY

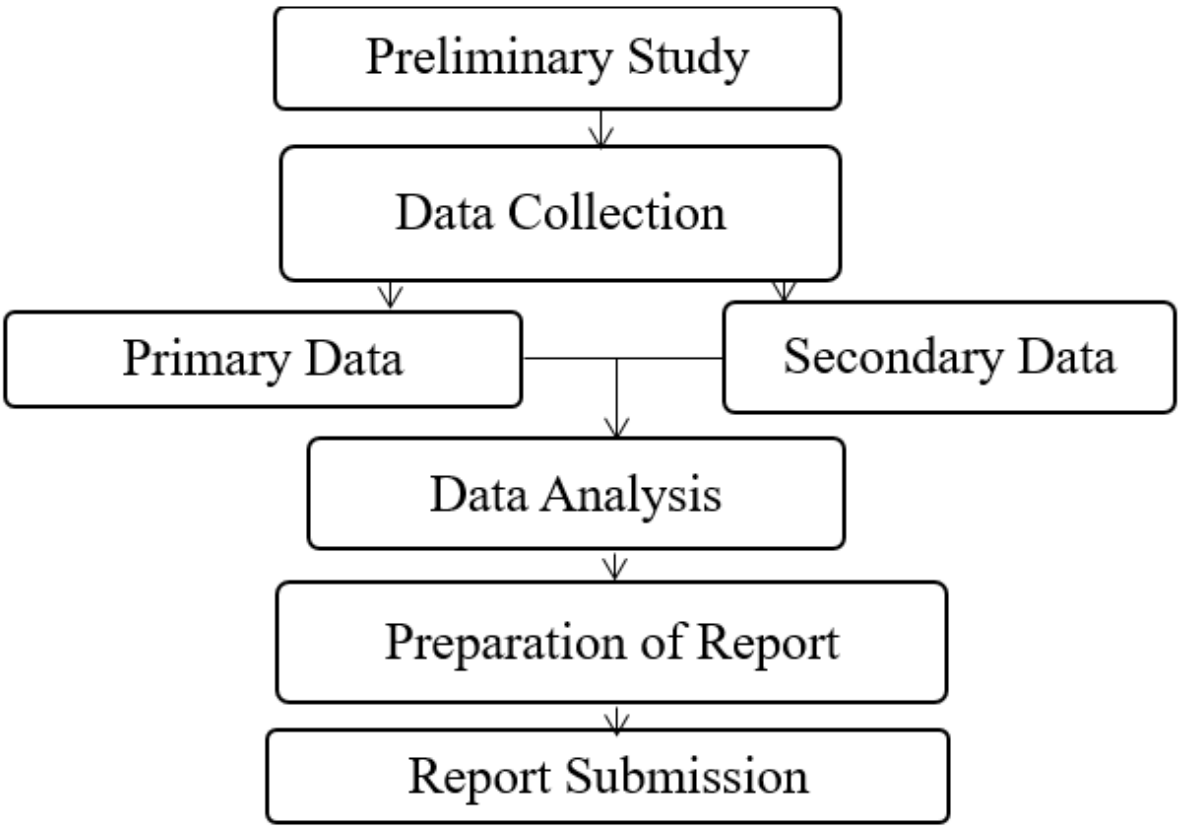


Figure 3: Flowchart of methodology

The quality assessment of cement in Nepal is typically done through testing and analysis of physical and chemical properties of the cement. This includes tests such as the fineness test, the soundness test, the setting time test, and the compressive strength test. The tests are performed in accordance with the standards and specifications set by the Nepal Bureau of Standards and Metrology (NBSM). The test results are then used to determine the compliance of the cement with the standards and to assess the overall quality of the cement. The testing and analysis are typically done by accredited laboratories that have been certified by the NBSM. To meet up the above-mentioned objectives, various methods can be done for this case study. The methods include primary research method and secondary research method.

3.1.1 DATA COLLECTION

Different brands of cement found in Nepal like Shivam cement, Hongshi cement, Jagadamba cement, and Maruti cement will be collected and following tests will be done.

3.1.2 Primary Data

1. Fineness of cement

In this test, the cement sample of different brands like Shivam, Sarbottam, Hongshi, Jagadamba and Maruti cement will be placed on top of the largest sieve and will be subjected to mechanical shaking to allow the particles to pass through the sieves. The weight of the cement retained on each sieve will be recorded and the results will be used to calculate the percentage of cement passing through each sieve size. The fineness of cement is usually reported as the percentage of cement passing through a specific sieve size. The sieving method is simple, easy to perform, and widely used to measure the fineness of cement. However, the accuracy of the method will be dependent on the quality of the sieves and the skill of the operator.

2. Initial setting time

In this test, the collected samples of cement will be mixed with water to form a paste of standard consistency. Then, the paste will be placed in the Vicat's apparatus. The cement paste will be left for setting freely and it will be checked after every 10 minutes because OPC cements has initial setting time as 30 minutes. The needle will be inserted into the paste and the time will be recorded when the needle comes into contact with the bottom of the paste and does not penetrate any further. The initial setting time is the time between the addition of water to the cement and the cement lose its plasticity.

3. Consistency of cement

In this test, the collected samples of cement will be mixed with water to form a paste of standard consistency. Then, the paste will be placed in the Vicat's apparatus. The plunger will be inserted into the paste at a specific depth (usually 1/10 or 1/8 of an inch) and the depth of penetration will be recorded, known as the length of plunger dip. The consistency of the cement paste will be determined by comparing the length of plunger dip to a standard scale or chart. The length of plunger dip is a measure of the consistency of the cement paste. A longer plunger dip indicates that the cement paste

is more fluid or wet, while a shorter plunger dip indicates that the cement paste is more stiff or dry. It will be reported in millimeters and the test results will be used to determine the compliance of the cement with the standards set by the Nepal Bureau of Standards and Metrology (NBSM) to assess the overall quality of the cement.

4. Compressive strength

The specimen mold will be filled with the cement sample, which will be cured for the specified period of time. After the curing period, the specimen will be placed in the testing machine and a load will be applied to the specimen using the loading platen. The load will be applied at a constant rate of loading until the specimen fails. The maximum load that the specimen can withstand before failure will be recorded and we will use it to determine the compressive strength of the cement. The compressive strength test results will be used to determine the compliance of the cement with the standards set by the Nepal Bureau of Standards and Metrology (NBSM) and to assess the overall quality of the cement. The test will be performed in accordance with the standard method for compressive strength of cement.

5. Soundness of cement

The most commonly used test for measuring the soundness of cement is the Le-Chatelier method. In this test, the collected samples of cement will be mixed with water to form a paste. Then, the paste will be molded into a cylindrical shape and will be allowed to set for 24 hours. The cylindrical sample will be immersed in water at a temperature of 27±1°C for a period of 15 hours. After the 15-hour immersion, the length of the cylindrical sample will be measured and recorded. Then, the cylindrical sample will be placed in an autoclave and subjected to steam pressure (at a temperature of 100±2°C) for 2 hours. After being removed from the autoclave, the sample will be cooled to room temperature and the length will be measured and recorded again. The expansion of the sample will be calculated by subtracting the original length from the final length and will be expressed as a percentage of the original length. The soundness of the cement will be evaluated by comparing the measured expansion to the specified limit, which is typically between 0.10% and 0.15%. If the measured expansion is within the specified limit, the cement will be considered to be sound. Cement from different manufacturing company can be tested with all the method for their physical as well as their chemical properties. The quality of the cements can be determined by comparing its result after the test with the standard value of the specific property and they can be categorized on the basis of their results.

Cement from different manufacturing company can be tested with all the method for their physical as well as their chemical properties. The quality of the cements can be determined by comparing its result after the test with the standard value of the specific property and they can be categorized on the basis of their results.

For fineness of cement, as per Indian Standard IS 4031 (Part 1) - 1996, for Ordinary Portland Cement (OPC), the minimum requirement for fineness is 95% of the cement should pass through a 90 μm (No. 200) sieve. For Portland Pozzolana Cement (PPC), the minimum requirement for fineness is slightly lower at 90% of the cement should pass through a 90 μm (No. 200) sieve.

For initial setting time, as per the Indian Standard IS 4031 (Part 1) - 1996, the minimum requirement for the initial setting time of Ordinary Portland Cement (OPC) is 30 minutes and the maximum is 600 minutes.

For the consistency, the standard value according to Nepal standard is 23-30% of water. If the cement exceeds more than 30% and less than 25% then, the result may vary causing the change in properties.

For compressive strength, as per the Indian Standard IS 4031 (Part 6) - 1988, the minimum compressive strength requirement for Ordinary Portland Cement (OPC) is 33 MPa (Mega Pascal) after 3 days of curing and 43 MPa after 7 days of curing. These values are considered the minimum standards for determining the quality of OPC in India.

For soundness test, as per the Indian Standard IS 4031 (Part 3) - 1988, the maximum expansion limit for Ordinary Portland Cement (OPC) is 10 mm. This means that the length change of the cement sample should not exceed 10 mm after being subjected to the soundness test.

We can find the quality of concrete and mortars made with different cements by testing its properties and by testing its compressive strength. We will perform compressive test of the concrete and mortar of the cement samples and compare the results with the standard values. In this way, we can finalize the quality assessment of cement by considering each and every test for each sample.

CHAPTER 4

4.1 WORK SCHEDULE

The work schedule from 1 February 2023 to 21 March 2023 includes study, group discussions, site work and report writing, and it is presented below:

S.N.	Activities/ Date	1-7 Feb 2023	8-14 Feb 2023	15-21 Feb 2023	22-28 Feb 2023	1-7 March 2023	8-14 March 2023	15-21 March 2023
1	Phase I: Initial stage / Project concept							
2	Literature review							
3	Phase II: Proposal development							
4	Proposal defense							
5	Phase III: Research methodology, data collection							
6	Result analysis and discussion and Conclusion and recommendation							
7	Report submission							

Table 2: Work schedule (Gantt Chart)

EXPECTED OUTCOME

The expected output from the study will be that there should be at most 10% cement retained in 90 microns sieve for OPC cement that we will be taking as sample. Similarly, for the initial setting time of the cement, the expected time for the setting of cement should be less than 30 minutes. For the test of the consistency of cement, the volume of water should be 25-35% relative to the volume of cement. Then, for the compressive strength test of cement, they will be categorized in three grades based on strength values obtained from the experiment:

- 53 grade cement: for minimum 53MPa strength in 28 days of curing
- 43 grade cement: for minimum 43MPa strength in 28 days of curing
- 33 grade cement: for minimum 33MPa strength in 28 days of curing

Keeping an eye on all these results of different cement samples, we will be concluding the final quality assessment of cement by comparing them with the standards codes according to Nepal standards or Indian Standard. Then, the cement sample with better results as compared to other cement samples will be considered as the best among the samples taken. Then, the cement which has highest and lowest compressive strength among the samples taken will be noted.

References

- Mishra A. K., Chaudhary U. (2018). Assessment of Cement Handling Behavior for Selected Construction Sites of Bhatbhateni Supermarket. J. Adv Res Const Urban Arch, 3(3), 1-11
- Banstola Prabin, Shrestha Kishor Kumar, Ishwor Thapa & Mishra, A.K. (2021). Assessment of Cement Consumption Pattern: A Case from Pokhara, Nepal. International Journal of Applied Engineering and Management Letters (IJAEML), 5(2), 26-37.
- Mishra, A. K., & Jha, A. (2019). Quality Assessment of Sarbottam Cement of Nepal. International Journal of Operations Management and Services, 9(1), 1-22.
- P. Ghosh, S. Mandal, B.D. Chattopadhyay, S. Pal, (2005), Use of microorganism to improve the strength of cement mortar, Cement and Concrete Research, Volume 35, Issue 10
- Bank, N. R. (2021). Foreign Direct Investment in Cement Industry in Nepal.
- Pandey, P. R., & Banskota, N. (2008). Process of cement production in Nepal. Bulletin of the Department of Geology, 11, 71-78.
- Jha, A., Mishra, A.K. (2019). Assessment of the Structure of Credit Policy and Sales Trend of Sarbottam Cement. J Adv Res Busi Law Tech Mgmt, 2(1): 14-20
- Mishra AK, Chaudhary U. Assessment of Cement Handling Behaviour For Selected Construction Sites of Bhatbhateni Supermarket.J Adv Res Const Urban Arch 2018; 3(3): 1-11.
- Mishra AK. Implementation Status of Value Management in Project Management Practice in Nepal, International Journal of Management Studies 2019; Vol.–VI, Issue –1(1).
- Mishra AK, Chaudhary U. Cost Effectiveness Assessment of Different Nepalese Cement Brands for Selected Sites of Supermarket.J Adv Res Const Urban Arch2018; 3(3): 12-33
- Mishra, A.K., & Shrestha, B.(2002). Assessment of Consumer Influencing Factor in Decision Making for Selecting Cement Brands South Asian Research Journal of Business and Management
- A K Mishra, (2018). Practices for Quality Management System Adopted in the Bridge Construction Projects of Kathmandu Nepal. J Adv Res Qual Control Mgmt, volume 3, issue 1&2, p. 42 – 52.
- Indian Bureau of Standards. (1989). Specification for Ordinary Portland cement.
- Indian Bureau of Standards. (1978). Specification for Ordinary Portland cement.