

# Physical Properties of Different Brands of Cement Manufactured in KPK, Pakistan: A Case Study

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**Abstract-** One of the key elements affecting structural concrete's strength and longevity is the cement's quality. In Pakistan, large amounts of cement are utilized in construction projects. This study appraised some physical properties of five brands of Portland cement bought from cement industries in KPK. Cement brands are investigated, including Cherat cement, Askary cement, Lucky cement, Kohat +, and Bestway cement. The composition of the cement has been recorded from the cement bags. Each initial setting time, normal consistency, final setting time, fineness, and compressive strength cement samples (collected as bags from the market) have been tested in the laboratory at three days, seven days, 14 days, and 28 days per ASTM standards. Amongst these various cement brands in KPK, we aim to investigate the best cement brands taking into consideration the above all physical test and then test these brands after three months. Taking time as a factor, the best cement quality is to be found. According to the fineness of cement, Cherat cement is found to be the best amongst all five brands of cement when tested initially, while lucky and Kohat were the least in fineness properties. Consistency tests were performed for all brands of fresh types of cement, and Cherat and Kohat have more consistency, while Askary has the least consistency. Initial and Final setting time tests were performed for all brands, and Cherat cement was found to have the more initial and final setting time, while Kohat and Askary had the least setting time. In the case of the compressive strength test, Cherat cement was found to be the greater strength, while lucky had the least compressive strength. For seven days curing. For 28 days curing Cherat cement was the best one having greater strength, while Askary had the least strength among all. All the cement brands were tested the same way after three months of age, which shows that all five brands crossed the ranges for each test. Still, it has been observed that the decrease in the fineness is small for Cherat compared to all other brands while in case of compressive strength, the decrease in Cherat is greater than all other brands.

**Index Terms**—ASTM standards, the strength of cement, cement, consistency of cement

## I. INTRODUCTION

The project deals with researching the quality of types of cement of various brands manufactured in the KP province of Pakistan. The most demanded construction material is cement. Cement can be easily available in global markets as it is used hugely in all types of construction. The construction industry requires millions of tons of cement to fulfill its needs. Cement is used everywhere at home, in buildings, bridges, and dams [1-4]. Cement used in construction is usually inorganic and can be characterized as either hydraulic or non-hydraulic cement, depending on the cement's ability to set in the presence of water. Cement is generally used to make mortar which provides strength to concrete. The sustainable use of cement is very much necessary due to today's world situation. For this purpose, the only solution to sustainable development is the life span of construction. The more the life span, the more sustainability is to be achieved. Using cement with the best properties can achieve the required goals and secure future generations and resources [5-7].

We have only checked five of these properties, which include

- Fineness of cement

- Final setting time
- Compressive strength test of cement
- Consistency of cement
- Initial setting time

These tests were performed on five different brands of cement manufactured in KP, which include,

- Askari cement
- Lucky cement
- Kohat cement
- Cherat cement
- Bestway cement

TABLE I. COMPRESSION STRENGTH REDUCTION WITH AGING

S.NO	Period	Reduction in Strength
1	3 months	21%
2	6 months	33%
3	12 months	42%
4	24 months	51%



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## II. METHODOLOGY

This research aims to evaluate the physical properties of different brands of cement. To achieve this objective, all the materials required for specimens were tested according to ASTM standards.



FIGURE 1. Sample of Cement

### A. MATERIALS

Three samples, as shown in Fig. 1, of each Portland cement are displayed as products of the following companies:

1. Cherat Cement Company,
2. Kohat Cement Company,
3. Lucky Cement Company,
4. Bestway Cement Company,
5. Askari Cement Company.

### B. TEMPERATURE

Each test was conducted at a room temperature of  $27 \pm 2$  °C, i.e., the room temperature

### C. VICAT APPARATUS:

The Vicat device must have a frame (A) supporting a moveable rod (B) weighing 300 g, a plunger end (C) with a diameter of 10 mm and a length of at least 50.0 mm, and another end with a replaceable needle with a diameter of 1 mm and a length of 50 mm. The rod has a set screw (E) that allows it to be retained in any position while reversible. It also has a movable indicator (F) that slides over a scale (graduated in millimetres fastened to the frame). A sturdy conical ring (G) perched on an approximately 100 mm square glass plate (H) supports the paste. The plunger must be perpendicular to the rod axis, the rod must be straight, and the rod must be made of stainless steel with a minimum Rockwell Hardness value of 35. The ring must be made of a non-corroding, non-absorbent material, have an interior diameter of 70 mm at the base and 60 mm at the top, and be 40 mm tall. The Vicat apparatus must also adhere to the following specifications and the ones listed above.

Weight of rod	$300 \pm 0.5$ g (0.661 lb $\pm$ 8 grains)
Diameter of plunger	$10 \pm 0.05$ mm (0.394 $\pm$ 0.002 in.)
Diameter of needle	$1 \pm 0.05$ mm (0.039 $\pm$ 0.002 in)
Height of ring	$40 \pm 1$ mm (1.57 $\pm$ 0.0 4in)
Inside ring diameter at bottom	$71 \pm 3$ mm (2.75 $\pm$ 0.12 in)
Inside ring diameter at top	$61 \pm 3$ mm (2.36 $\pm$ 0.12 in)



FIGURE 2. Vicat apparatus

The consistency of the cement samples was determined using the Vicat apparatus (see Fig. 2). Before mixing it thoroughly with 25% water by weight of the dry cement for 5 minutes to get a cement paste, after which the paste was used immediately to fill the Vicat mould. The plunger was then brought into contact with the top surface of the mould and quickly released to allow the plunger to penetrate the paste under the action of its weight. The penetration depth was measured and recorded from the scale reading of the Vicat apparatus after 30 seconds.

### D. PREPARATION OF MORTAR:

- 1) Add the cement to the dry mixing bowl after adding the necessary water. With the mixer running at low speed immediately, add the sand gradually over the next 30 seconds.
- 2) Spread a layer of mortar over the area and 25 times press it down.
- 3) After tamping is complete, the tops of each cube should stick out just a little bit above the mould rims. Use a trowel to smooth the cubes by running the trowel's flat side across them after bringing in the mortar that has been squeezed onto the tops of the mould (see Fig. 3).



FIGURE 3. Preparation of cement

### E. STORAGE SPECIMENS

Place the test specimens in the wet room or closet as soon as the moulding is finished. Please keep all specimens in the mould on the base positions for 21 to 25 hours after moulding, with their upper surfaces exposed to the air but protected from dripping water. After 24 hours, take the specimen from the mould and submerge it in water. Also, Change the water in the storage tank to keep it clean (see Fig. 4).



FIGURE 4. SAMPLES OF CUBES

### F. LOADING

The loading of each specimen was gradual with a continuous/regular increment until its breaking load in compression (or maximum load it can sustain without breaking, Pmax) was obtained and recorded. The concrete compressive strength of each specimen was determined from the following relation.

$$\sigma = P_{max}/A \quad (1)$$

where A is the surface area. The average results were found by testing the six specimens of each cement sample, three of which were tested after 7 days and the remaining three after 28 days curing. Then taken as the concrete compressive strength of that sample while the average of the three samples of each brand of cement was taken as the brand's compressive strength (see Fig. 5).



FIGURE 5. MANUAL UTM MACHINE

## III. RESULTS AND DISCUSSIONS

### A. FINENESS OF CEMENT

TABLE II: FINENESS OF CEMENT

Brands	Percent Fineness
Cherat	97.4%
Bestway	92%
Askari	91%
Lucky	87.9%
Kohat	87.9%

According to ASTM standard, "Percentage of cement passed from sieve#200 must greater or equal to 90%" (see Tab. II). So according to our research CHERAT cement brand have the highest fineness, followed by Bestway and Askari, while Lucky and Kohat have the poorest fineness (see Fig. 6).

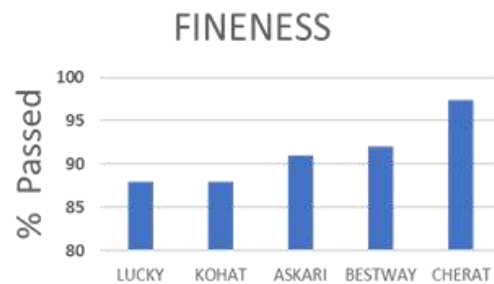


FIGURE 6. Cement Fineness

### B. CONSISTENCY:

According to ASTM standard

"Rod settles to the point 4-7mm above the bottom surface in 30 sec after being released". If we exceed that amount of water, bleeding will happen. If we add less quantity of water, dry mix will happen. For that purpose, we do a consistency test (see Fig. 7). So, according to our research, All of the Brands follow standard consistency except Kohat Cement. Still, Kohat Cement Brand also has a consistency very nearer to the ASTM standard, which is acceptable (see Tab. III).

TABLE III: CONSISTENCY OF CEMENT

Brands	Consistency	Water Added
Cherat	7mm	29%
Askari	7mm	26%
Lucky	7mm	27%
Bestway	6mm	27%
Kohat	8mm	29%



FIGURE 7. Consistency of cement

### C. INITIAL SETTING TIME

According to ASTM standard The initial setting time must be at least 30 minutes. The setting time of cement must be constant, neither too fast nor too slow. The concrete may not have enough time to be transported and laid before it hardens to an unsatisfactory degree in the first scenario. In the second situation, a protracted setup period often causes work to proceed more slowly than necessary. It may postpone the actual use of the structure because it might not be strong enough when it should be by that point. The initial setting time (see Table IV) test is essential for cement concrete's transportation, installation, and compacting. A first setup period is required to delay the hydration or hardening process. According to our research, Lucky Cement has the shortest initial setting time while Cherat Cement has the longest first setting time (180 mins) (98 mins). Each brand complies with ASTM standards.

Table IV. INITIAL SETTING TIME FRESH CEMENT

Brands	Time (Mins)	Penetration (mm)
Kohat	97	40
	112	39
	125	36
	137	34
Lucky	50	40
	83	37
	98	34
Askari	118	40
	122	36
	148	34
Bestway	150	39
	180	37
	203	35
Cherat	132	39
	162	39
	180	35

### E. FINAL SETTING TIME

TABLE V. Final setting time old cement ( 3 months)

Brands	Time (Mins)
Cherat	220
Kohat	225
Bestway	253
Lucky	207
Askari	253

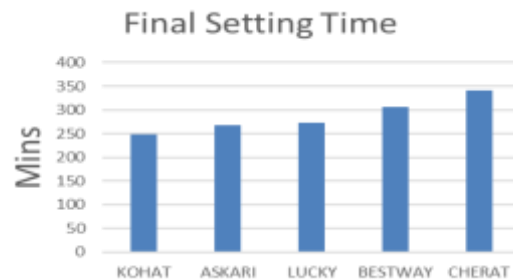


FIGURE 8. Final setting time

### F. COMPRESSIVE STRENGTH TEST (7 DAYS CURING)

Brands	Compressive strength (psi)
Askari	1961
	2027
	2920
Avg=2302	
Kohat	1038
	2027
	2060
Avg=2041	
Cherat	1333
	1641
	1697
Avg=1557	
Bestway	914
	1201
	859
Avg=991	

FIGURE 9. Compressing strength for 7 days curing

### G. COMPRESSIVE STRENGTH FOR EIGHT DAYS CURING

Brands	Compressive strength (psi)
Askari	2810
	2529
	2697
Avg=2678	
Kohat	1807
	2556
Avg=2181	
Cherat	1807
	1410
	1278
Avg=1498	
Bestway	1212
	1190
Avg=1201	
Lucky	1592
	1608
	1840
Avg=1680	

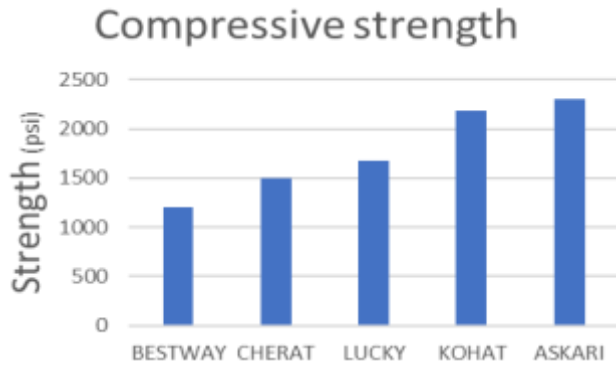


FIGURE 10. Compressive strength for 28 days of curing.

#### IV.CONCLUSIONS

From all of our experimental work, we concluded that from all of our data, we selected the cement, which is mostly best in almost all of the properties. The final testing setup is given in Tab. V and the results are shown in Fig. 8, 9 and 10. And this results that Cherat cement behaving as the number one cement among all cement brands manufactured in KPK. In the case of expired cement, we must know why people do not like to use cement after three months, so we came to the conclusion that after 3months, the physical properties are very far from ASTM standards. Almost all of the properties failed in qualifying ASTM standards. None of the cement brands fulfills the requirements of ASTM standards, and no cement brand satisfies even a single physical property, so we conclude that cement of age three months and onwards have expired and are not capable of use.

#### V.RECOMMENDATIONS

As Cherat Cement fulfilled almost all the properties with the best performance concerning fineness, compressive strength, more time to lose its plasticity, more time to start losing its plasticity. So, we recommend CHERAT cement for the people of KPK Pakistan.

We also recommend from our research work that cement of any of the brands in KPK can be used within three months of its aging. After three months, the cement of any brand of KPK is recommended as expired and cannot be used for even a small work.

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The authors declare they have no conflicts of interest to report regarding the present study.

#### CONFLICT OF INTEREST

The Authors declare that they have no conflicts of interest to report regarding the present study.

#### REFERENCES

- [1] R Haque, S purkayastha, "Variation of Physical Properties of Cement over Time" International Journal of Engineering and Technology vol. 10, no. 6, p. 434-439, Dec 2018 DOI: [10.7763/IJET.2018.V10.1098](https://doi.org/10.7763/IJET.2018.V10.1098)
- [2] [2] Y S chu, J K lee, "The Effects of Elvan on Physical Properties of Cement Mortar" Journal of the Korea Concrete Institute vol. 15, no. 3, June 2003 DOI: [10.4334/JKCI.2003.15.3.386](https://doi.org/10.4334/JKCI.2003.15.3.386)

- [3] P S yalamarty, "Studies on the Assessment of Cement Parameters of Different Brands of Cements" October 2018 *Some studies on Different Brands of Cements available in the market.*
- [4] M Ogbodo, AI Akabot, "An assessment of some physical properties of different brands of cement in Nigeria" February 2021 IOP Conference Series Materials Science and Engineering DOI: [10.1088/1757-899X/1048/1/012013](https://doi.org/10.1088/1757-899X/1048/1/012013)
- [5] David Lenczner, "Properties of Mortars" Elements of Loadbearing Brickwork December 1972 DOI: [10.1016/B978-0-08-016814-2.50009-9](https://doi.org/10.1016/B978-0-08-016814-2.50009-9)
- [6] Y. Guo, G Gao "Dynamic Properties of Mortar in High-strength Concrete" International Journal of Impact Engineering March 2022 DOI:[10.1016/j.ijimpeng.2022.104216](https://doi.org/10.1016/j.ijimpeng.2022.104216)
- [7] H Z lu, H M mei, "Properties of Mortar with Recycled-Cement" Applied Mechanics and Materials *august* 2012 DOI: [10.4028/www.scientific.net/AMM.193-194.397](https://doi.org/10.4028/www.scientific.net/AMM.193-194.397)