



A Practical Handbook for Safe, Smart and Durable Construction in Ghana

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Imprint

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in Ghana

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Table of Contents

1. Introduction	vi
2. General Use of Cement	1
3. Mixing and Consistency	5
4. Cement Quality Control Checks	16
5. Safety and Good Practices	18
6. Environmental Protection	23
Institutional Context and Acknowledgements	24
Feedback Form/Contact Information	25

1. INTRODUCTION

Concrete is the most widely used building material, and as Ghana advances its infrastructure and housing, it is crucial to build safely and durable structures and to use building materials efficiently to prevent waste. Cement, the primary binder used in concrete, must be handled safely due to its harmful chemicals that can cause long-term damage and it must not be used wastefully to save money and to reduce the carbon footprint of the construction sector.

This handbook provides guidelines on the safe use of cement and concrete, the various types of cement available and their uses, and important health and safety considerations. The Ghana Standards Authority (GSA) is responsible for public education and consumer protection of Ghanaians and in collaboration with the Federal Institute for Materials Research and Testing (BAM), the Ghana Standards Authority developed this handbook to offer essential information and guidelines for the safe handling and quality inspection of cement.

Self-built projects are common practice. Building and construction work does not always fully happen in the formal environment, often people use cement products for small repair work or extending houses.

2. GENERAL USE OF CEMENT

Types of Cement and Their Applications

Various cement types are available on the market, each with specific applications. Choosing the right type is essential for achieving the desired strength and durability. Common cement types include:

- Portland cement
- Blended cement
- Specialty cement

Recommended applications by cement strength classes:





General construction like masonry work and screeding.

- Ordinary Portland cement
- Portland limestone cement
- Portland pozzolana cement
- Portland composite cement

CEM I 32.5, CEM II 32.5, CEM III 32.5 or LC3 32.5

Rapid hardening (R), Normal hardening (N)



Structural concrete works and manufacture of concrete products like building blocks or pavement blocks.

- Ordinary Portland cement
- Portland limestone cement
- Portland pozzolana cement
- Portland composite cement

CEM I 42.5, CEM II 42.5, CEM III 42.5 or LC3 42.5

Rapid hardening (R), Normal hardening (N)



Ideal to produce ready-mixed concrete and to be used for high-rise.

- Ordinary Portland cement
- Portland limestone cement
- Portland pozzolana cement
- Portland composite cement

CEM I 42.5, CEM II 42.5, CEM III 42.5 or LC3 32.5

Normal hardening (N)



For ready-mixed concrete and high-rise buildings including pre-cast concrete elements such as beams, columns,

- Ordinary Portland cement
- Portland limestone cement
- Portland pozzolana cement
- Portland composite cement

CEM I 52.5, CEM II 52.5, CEM III 52.5 or LC3 42.5

Rapid hardening (R), Normal hardening (N)



ONLY: Plastering, block laying, tiling, and screeding.

- Ordinary Portland cement
- Portland limestone cement
- Portland pozzolana cement
- Portland composite cement

MC 12.5 or MC 22.5

- NOT FOR STRUCTURAL PURPOSES
- DO NOT MIX WITH OTHER CEMENT TYPES

Cement Strength Classifications

Understanding strength classifications is crucial when selecting cement for different applications:

- “R” represents rapid or early strength development.
- “N” represents normal or standard strength development.

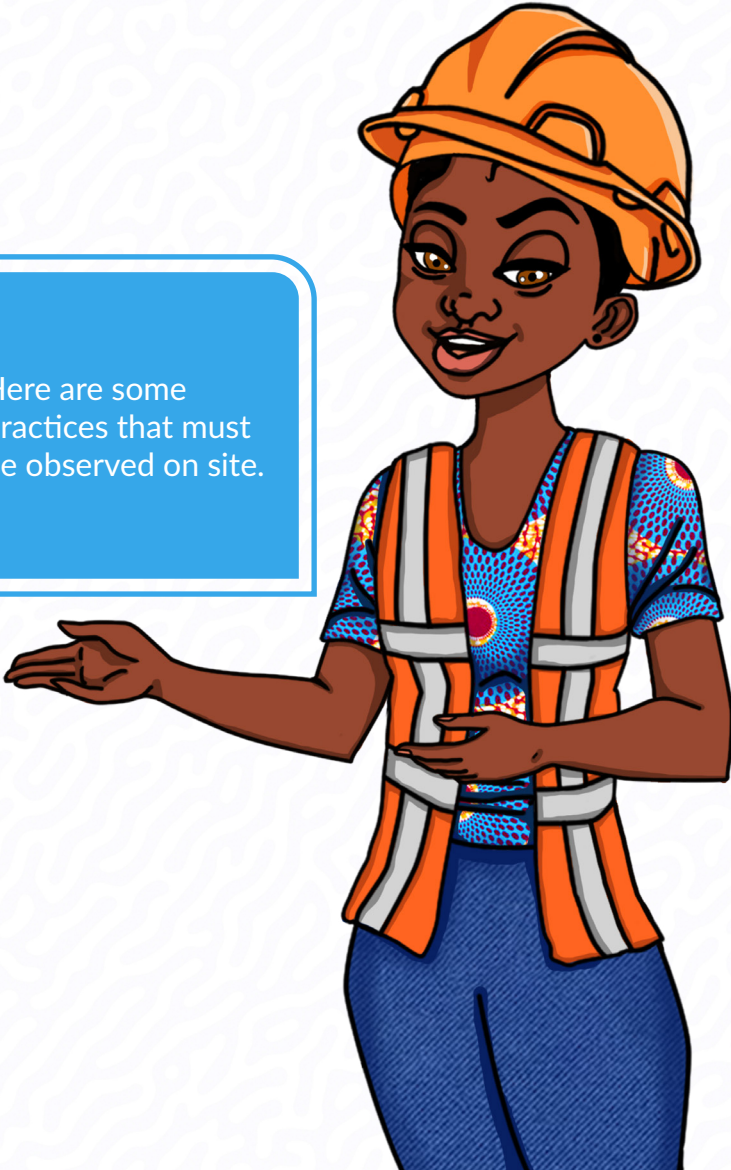
The numerical values indicate strength levels:

- 32.5: Low strength after 28 days
- 42.5: Medium strength after 28 days
- 52.5: High strength after 28 days

Note: Cement strength continues to evolve beyond 28 days, so the strength classes after this period may not reflect the final strength order.

3. MIXING AND CONSISTENCY

Here are some practices that must be observed on site.



Surface Preparation: Before applying cement, ensure that surfaces are clean, dry, and free of debris. Proper surface preparation is essential for optimal adhesion and performance.



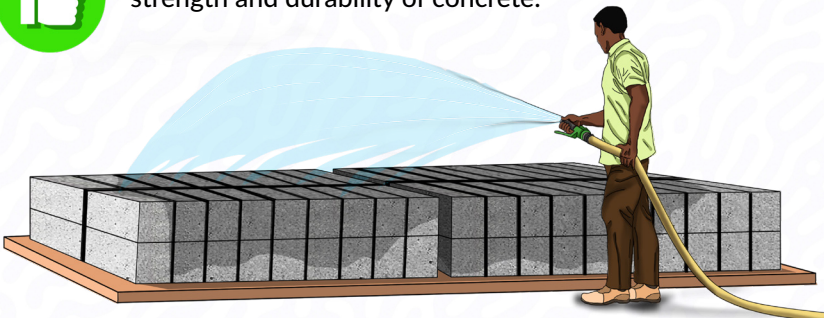
Wearing of personal protective equipment while on site.

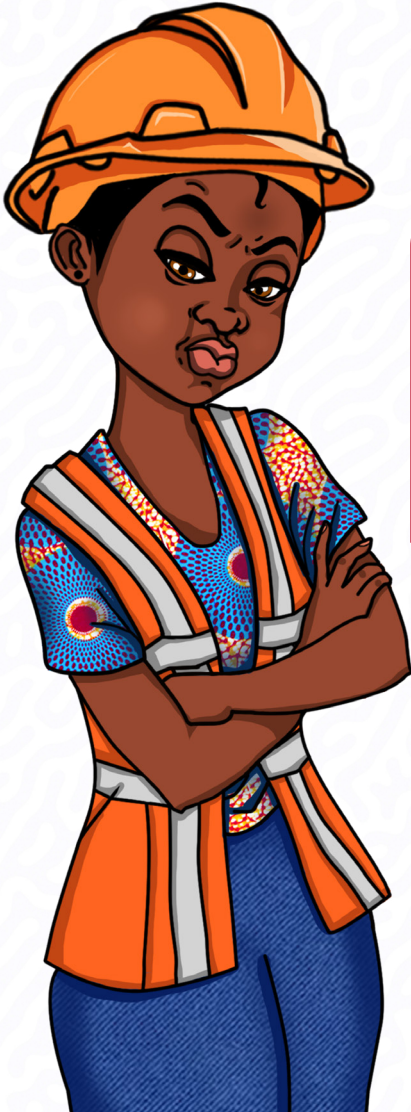


Proper mixing ensures the desired consistency and strength of the concrete.



Proper curing is critical for the strength and durability of concrete.





Here are some common practices which must be avoided on site.



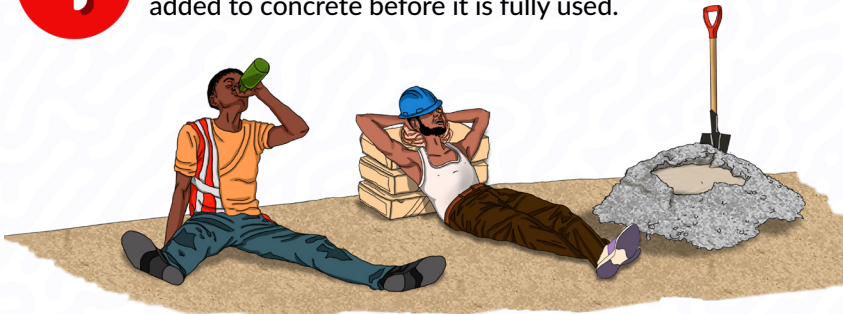
Adding too much water to concrete mortar compromises the quality and strength.



Mixing different cement types in mortar must be avoided.




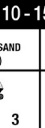
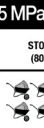


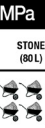



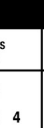
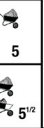


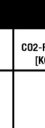
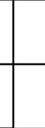


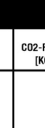
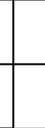


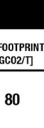
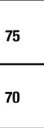













No lunch breaks after water has been added to concrete before it is fully used.



MIXING RATIOS

It is important to adhere to proper application techniques with appropriate tools and Personal Protective Equipment (PPE) (which is detailed in section 5) to minimise risks when pouring concrete, layering bricks, and repairs. Where possible/available follow the manufacturers' instructions and recommended mixing ratios when preparing cement and concrete mixtures. Proper mixing ensures the desired consistency and strength of the concrete.


Here are two tables illustrating all the class of cement and their mixing ratio by measurement of 80 kg wheelbarrows and 10 litre buckets.














MIXING RATIO FOR CONCRETE						
MEASURING METRICS BY 80 LITRE WHEELBARROWS & 10 LITRE BUCKETS						
LOW CONCRETE STRENGTH: 10 - 15 MPa						
CONCRETE SPECIFICATIONS	NO. OF CEMENT BAGS (50 KG)	COARSE SAND (80 L)	STONES (80 L)	WATER (10L)	VOLUME IN m ³	CO ₂ -FOOTPRINT [KGCO ₂ /T]
32.5		 3	 4		0.45	80
42.5		 3 ^{1/2}	 5		0.50	75
52.5		 4	 5 ^{1/2}	 8	0.55	70
MEDIUM CONCRETE STRENGTH: 20 - 25 MPa						
CONCRETE SPECIFICATIONS	NO. OF CEMENT BAGS (50 KG)	COARSE SAND (80 L)	STONES (80 L)	WATER (10L)	VOLUME IN m ³	CO ₂ -FOOTPRINT [KGCO ₂ /T]
32.5		 3	 4 ^{1/2}		0.45	110
42.5		 3 ^{1/2}	 5		0.50	100
52.5		 4	 6	 8	0.55	90
HIGH CONCRETE STRENGTH: 30 - 35 MPa						
CONCRETE SPECIFICATIONS	NO. OF CEMENT BAGS (50 KG)	COARSE SAND (80 L)	STONES (80 L)	WATER (10L)	VOLUME IN m ³	CO ₂ -FOOTPRINT [KGCO ₂ /T]
32.5		 3	 4		0.45	145
42.5		 3 ^{1/2}	 5		0.50	125
52.5		 4 ^{1/2}	 6	 8	0.55	105

The table below demonstrates the number of cement bags (50 kg) by measurement of 80 litres using wheelbarrows and 10 litres buckets each masonry requirements.

MIXING RATIO FOR PLASTERING MORTAR & SCREEDING

MEASURING METRICS BY 80 LITRE WHEELBARROWS & 10 LITRE BUCKETS



MIXING RATIO FOR PLASTERING AND MORTAR						
APPLICATION	NO.OF CEMENT BAGS (50 KG)	COARSE SAND (80 L)	WATER (10 L)	MIX RATIO	SQUARE AREA	
PLASTERING (12 mm)		 2	 2 ^{1/2}	1:4	12 m ²	
PLASTERING (20 mm)		 2	 2 ^{1/2}	1:4	6 m ²	
BRICKLAYING MORTAR ((10-12 mm)		 2	 2 ^{1/2}	1:4	10 m ² WALL AREA	
MIXING RATIO FOR SCREED						
APPLICATION	NO.OF CEMENT BAGS (50 KG)	COARSE SAND (80 L)	STONES (80 L)	WATER (10 L)	MIX RATIO	SQUARE AREA
SCREED (25 mm)		 2	 2	 2	1:4	10 m ² FLOOR AREA

WATER- CEMENT RATIO

The water that is added to the mix is decisive for the consistency and the strength. More water gives better consistency and compacting ability, but the more water that is the lower the strength will be. The water-cement-ratio defines the mass proportions of water to cement. A good water to cement ratio by weight is 0.5 to 0.6. This corresponds to 24-30 litres of water per 50 kg bag of cement, or one bucket of water and one bucket of cement powder.



Cement water in adequate amount.



Poor pervious concrete: mixing cement with very little water makes the concrete highly compact with no air or water to pass through.



Poor watery concrete: mixing cement with too much water leads to water retention inside the concrete that eventually evaporates leading to cracking under heavy load.



Good concrete: mixing cement and water with an appropriate ratio for intended usage, less water leaves smaller pores for strength development.

MIXING RATIO (CEMENT BAG LABEL)

Responsible cement producers can provide specific user and safety instructions on the bag as this example below.



Mix Consistency: Check the consistency of the cement mix to ensure it meets the desired specifications. Adjust water-to-cement ratios as needed to achieve the desired results.

We have all been here before...



- 1.** As you carefully pour your dry aggregates together, following your perceived ratio.



- 2.** Next, you thoroughly mix your mortar into a homogenous mix.



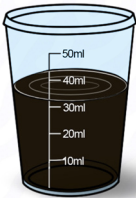
- 3.** However, as you continue, you notice the mixture is much stiffer than expected, making it difficult to work with.



When this happens...

Don't add water!

Ensure to add a **superplasticizer** or add more **cement paste** to achieve a more workable mortar/concrete.

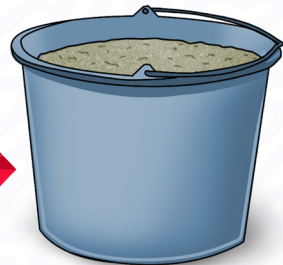


Superplasticizer

OR



Cement paste



Workable mortar

4. CEMENT QUALITY CONTROL CHECKS

Cement Bag Inspection

To ensure the quality of the purchased cement, there are screening points that can be confirmed on the cement bag. According to the Ghana Standards (GS 1118: 2016), cement bags must be marked with the following information:

- The name, address, trademark, or other means of identification of the manufacturer to facilitate to the works in which the cement was manufactured.
- The name and strength class of the cement e.g. Portland cement, class 32.5N
- The number and date of the Ghana Standard i.e. GS 1118 (or equivalent international standard)
- Date of manufacture (month/year)
- Batch number (inclusive of location)
- The net mass in kg
- Ghana Standards Certification Mark (or quality mark of an accredited certification body)
- Country of origin (e.g. Made in Ghana)
- Instructions of use
- Conditions of storage (e.g. store in dry, airy place)
- Any additional information

A summarised version of the required markings is shown below:



Additional inspections:

- Inspect the cement bag for visible damages or re-closure
- Avoid purchasing cement from opened bags
- *Tip: Use a QR code (if available) to access cement details and the online version of this handbook.*

5. SAFETY AND GOOD PRACTICES

Cement contains hazardous chemicals and leads to health complications if not used properly. Some of the complications related to cement use includes chemical burns if in contact with skin or eyes, dermatitis, or skin irritation. When the highly alkaline cement paste touches your eyes, this may cause blindness. Wash your eyes carefully with a lot of water. Never wash your face or hands with water from the same container that was used for transporting concrete before.



Washing face with cement water



Can lead to blindness

Skin Protection

Cement can cause skin irritation and chemical burns upon prolonged contact. Wear long sleeves, pants, and waterproof gloves to protect your skin. In case of exposure to skin and eyes wash off any cement residue immediately with water and soap.

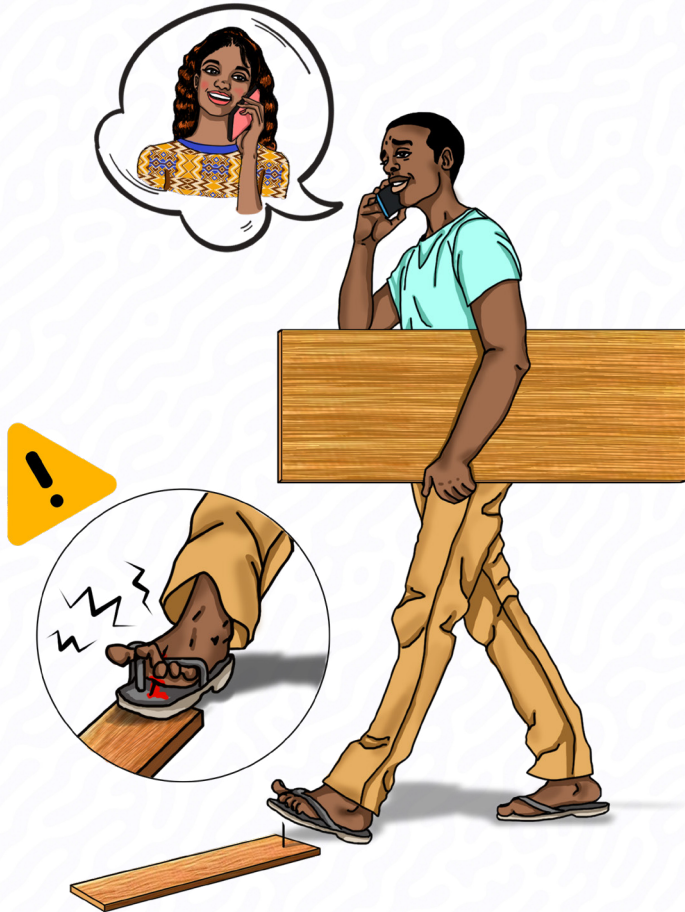


Direct skin contact with wet cement



Can lead to burns

Always be alert and pay attention when on a construction site to avoid accidents. Distractions and lacking care cause injuries!



Personal Protective Equipment (PPE)

Always wear appropriate PPE, including gloves, safety glasses, and a dust mask, when handling cement. Importantly, avoid inhalation cement dust. It can irritate the respiratory system and cause long-term health issues. Minimize dust generation by using wet cutting methods for concrete and have proper ventilation or wear mask when possible.



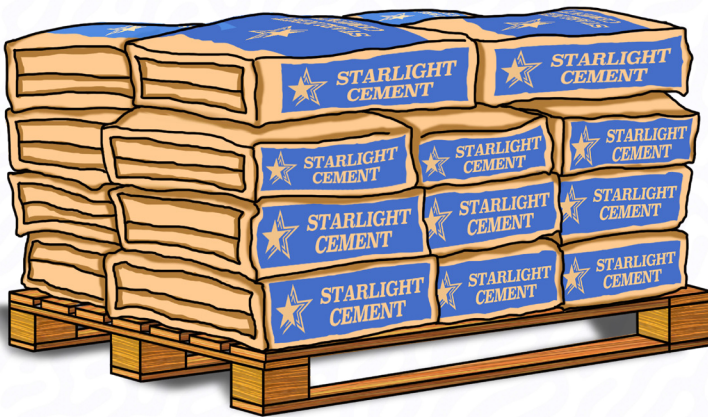
Handling of Cement Bags

Carefully lifting the cement bags can help avoiding back injuries from the load of the bag and tearing. Importantly, use your legs to lift and never bend down to lift with your back.



Storage of cement bags

Store cement bags in a dry, well-ventilated area off the ground to prevent moisture absorption and keep away from water and humidity. Storing open bags for prolonged times leads to reduced quality of the cement. Bags cannot be stored indefinitely and need to be inspected regularly for signs of hardening or clumping. In case of hardened lumps in the bag, positively avoid using the cement for any relevant structure. Never use it for load bearing structures.



First Aid Measures

It is advisable to have a first aid kit on the site. In case of skin or eye contact with cement, promptly rinse affected areas with fresh water. Seek medical attention if irritation persists or if cement enters the respiratory system or eyes.

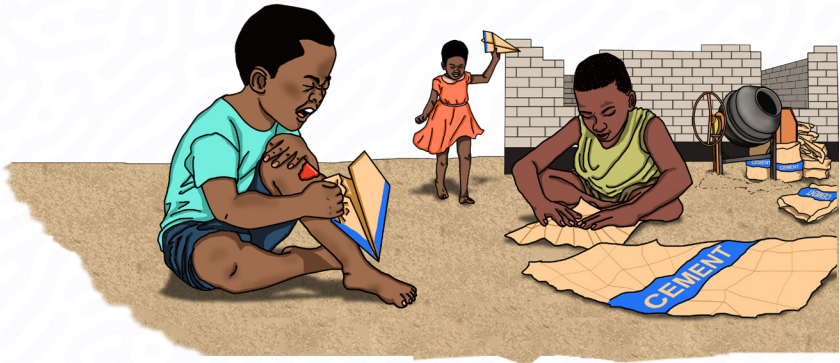


**EMERGENCY
NUMBERS**

**AMBULANCE- 193
NATIONAL FIRE SERVICE: 192**

6. ENVIRONMENTAL PROTECTION

- Use appropriate cement volumes to avoid waste. Any leftover cement can be used for minor projects like patch repair.
- Keep the construction site clean to prevent injuries, especially when children can access the construction site.
- Never store cement bags in humid or rainy conditions, as moisture will affect the quality of the cement.
- Never leave dangerous tools lying around a public space.
- Be mindful of the water usage and avoid wasting water. The less excess water you use the better the quality of the concrete.



(Figure of a child playing with old cement bags getting injured).

INSTITUTIONAL CONTEXT AND ACKNOWLEDGEMENTS

This informational handbook has outlined essential guidelines for handling, mixing, and storing cement, while emphasizing the importance of quality control and personal safety. It provides guidance for all who engage in construction- whether professionals, informal sector practitioners and individuals working on personal projects. It does not alter, substitute, or determine compliance responsibilities in all Ghanaian standards implemented by the Ghana Standards Authority standards including the (GS 1118: 2016).

This handbook was written and edited within the scope of the “Improving the Standards of Public Test Laboratories in the field of Construction Materials and Chemicals” an institutional partnership between the Ghana Standards Authority (GSA), the Federal Institute for Materials Research and Testing (BAM), the Federal Ministry for Economic Affairs and Energy (BMWE) of Germany and the the Ministry of Trade, Agribusiness, and Industry (MoTAI) of Ghana. The project was funded by the Federal Ministry for Economic Affairs and Energy (BMWE).

An institutional partnership between:



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GHANA
STANDARDS
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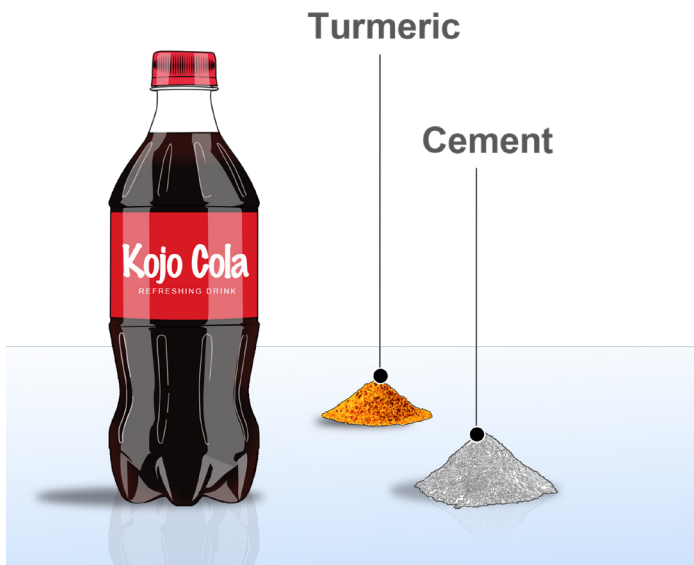


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The
Clinker
Test





Where the beverage cola is used along with turmeric powder. Cola typically has a pH value between 2.4 and 3. When mixed with cement (here 0.25g of cement on 10g of cola) the cement dissolves with time changing the pH value from below 8 to above 10 over the course of 20 minutes.

Turmeric is a pH indicator, that changes from yellowish to red with increasing pH. The conversion takes place at approximately pH 7.4, but a clear change to red can be observed rather around pH 9. Figures shows an example of the same mixture proportioning over the course of time, and initially the liquid appears yellowish, then changes around 10 minutes before it becomes clearly red after 15 minutes. The colour changes clearly coincide with the changes of the pH shown in Figures.

The figure in addition shows the pH change for a sample where a 20% weight fraction of the reactive clinker was replaced by quartz filler and by quicklime, respectively. The cement with the lower clinker content remains below the threshold for the colour change, while the immediate reactivity of the quicklime causes the colour change to happen immediately. Colour change of the test samples with reference cement over the course of time.



The mixture of coca-cola(10 g), turmeric and cement(0.25 g) where the cement dissolves with time changing the pH value.



The pH value from below 8 to above 10 changes colour over the course of 20 minutes.



A clear change of colour from yellow to red can be observed with increasing pH.





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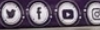
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A collaboration focusing
on improving the standards
and processes in public test
laboratories in the field of
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