Experiment Guidance

Engineering Material Experiment Reference

1. Objects

Civil Engineering Material is the practice section in the teaching. Its objects are:

Get familiar with civil engineering material standards, regulations and technical requirements; learn about materials properties and state.

Learn about basic experiment methods and operations, use instruments and settings, inspect regular material quality

Carry out basic research training and process data, cultivate the research and analysis ability and work our solutions. Be critical about scientific study and research work

Make students more creative and improve their practice ability by the combination of theoretical study and practice.

2. Basic Requirements

Preview and understand test purpose, basic principle and operations. Learn to use instruments and materials

Set up strict procedures in the experiments and abide by the operations. Observe carefully in the experiments and take records in detail.

Analyze test result and write report.

It is required to carry out the tests according to the experiment guidebook , design plans, make conclusions and find out regulations in the opening experiments.

Experiment program settings

Experiment List

No.	Name	Hours	Requirement	Type	Group
1	Basic Properties	1	Required	Confirmation	Basic Experiment
2	Cement Properties	2	Required	Confirmation	
3	Concrete Aggregate – Sand and stone	2	Required	Confirmation	
4	Cement Concrete	3	Required	Design	

3. Notes

3.1 Sampling should be typical；

3.2 Test technology, including selecting instruments, making samples and testing conditions and methods；

3.3 Process data. Material quality index and data obtained in the experiments are conditioned and relative in that it varies with sampling, testing and data processing. Therefore, quality examination and marking grade should be in accordance with national standards and verified methods, otherwise, it can not be graded or compared.

4. Editor's Words

4.1 This guidebook is written in accordance to new teaching and experiment syllabus and national standards or verified resources. It does not cover all the material in civil

engineering material.

4.2 This guidebook is subject to updated revision with the development of science and technology and standards and test methods amendments. Please consult relevant reference if necessary.

5. Catalogue of Experiment Guidebook

（I）Basic Experiments

(1) Basic Properties（Opening Experiment: Confirmation）

I Object

To learn basic physical properties and testing scientific principle and methods .

II Instrument and Settings

pycnometer, oven, desiccator, balance, constant temperature water tank, vernier caliper

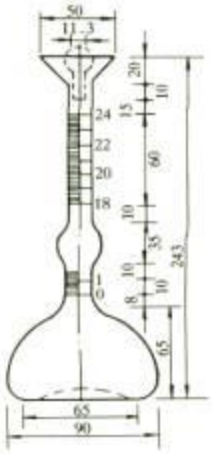


Fig.1 pycnometer

III Methods and Procedures

（i）density test

（ii）apparent density（volume density）test

（iii）Porosity Test

（iv）Absorption Test

IV Data record and process

（i） density test

name ：_____ temperature：_____ water temperature：_____

No.	Weight (g)	Initial Reading on Pycnometer (mL)	Final Reading on Pycnometer (mL)	Absolute Density Volume (cm^3)	Density (g/cm^3)
				Ave.	

notes：Accuracy up to 0.01

（ii）apparent density test

sample name：_____ sample state：_____

No.	Length (mm)	Width (mm)	Thickness (mm)	Volume (mm^3)	Weight (g)	Apparent Density (kg/m^3)
					Ave.	

notes：Accuracy up to 0.01, the final apparent density saves the integer.

（iii）Calculate Porosity and Solidity

Porosity P

Solidity D

（iv）Water Absorption Test

name ：_____ Temperature：_____

No.	Dry Weight (g)	Weight after Saturation (g)	Water Absorbed (g)	Specific Absorption of Weight (%)	Specific Absorption of Volume (%)
			Ave.		

VI、Result Discussion and Analysis

（i）Does the results satisfy the requirements?

（ii）Does stone sample fineness affect density testing result? Why?

VII、Questions

Please analyze the pore structure in this experiment , according to porosity and specific absorption of volume result.

(2) Cement Properties（Basic Experiment--Confirmation）

I Object

To understand GB175－85 regulation, learn to inspect cement quality and make strength sample, understand the effect of cement technical index on the project.

II Scientific Principle

According to the national standard, experiments on basic properties of cement fineness, water amount for normal consistency, setting time, soundness and strength.

III Instrument and Settings

sieve machine, water sieve, dry sieving, water sum for normal consistency apparatus, cement mixing machine, cement mortar setting time machine, maintenance box, boiling box, clincher, expand goniophotometer, cement plain bumper, bending strength testing

machine, compressive strength testing machine, clincher for compressive, balance.

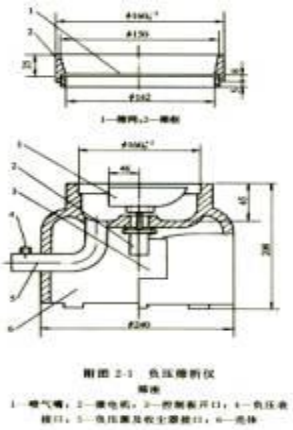


Fig.1 sieve machine

Fig.2 water sum for normal consistency

Fig.3 cement mortar setting time machine

Fig.4 boiling box

Fig.5 expand goniophotometer

Fig.6 cement mixing machine

Fig.7 cement plain bumper

Fig.8 bending strength testing machine

Fig.9 compressive strength testing machine

IV Methods and Procedures

For details see the Video clip.

V Data Record and Process

Cement Type &Mark：_____ Producer and Production Date：_____

Temperature：_____ Humidity：_____

（i）Cement Fineness Test

Method	Dish (g)	Cement (g)	Dish (g)	Dish and Cement Remainder (g)	Remainder (g)	Remainder Percentage (%)
Water Sieve Method						
					Ave.	

Note: weight accuracy up to 0.1g

（ii）Water Sum for Normal Consistency Test（Fixed Amount）

Times	Cement (g)	Water (ml)	Test cone depth S (mm)	Water for normal consistency P (%)

（iii）Cement Mortar Setting Time Test

No.	Water Sum for Normal Consistency P (%)	Time (hh／mm)	Initial Setting Time (hh／mm)	Final Setting Time (hh／mm)	Setting Time (hh／mm)	
					Initial Setting	Final Setting

（iv）Cement Soundness Test

No.	Water Sum for Normal Consistency P (%)	Sample Made (dd／hh)	Inspecting Date (dd／hh)	Result	Qualified／Disqualified

（v）Strengh Test

Shaping Date ____ (mm／dd); Test Date _____ (mm／dd); Aging days _____ days

No.	Bending Strength Test			Compressive Strength Test			
	Overload (N)	Bending Strength (MPa)	Ave. Strength (MPa)	Pressured Area (mm^2)	Overload (N)	Compressive Strength (MPa)	Ave. Strength (MPa)

VI Result Analysis and Discussion

1.According to the national standards,is the tested cement applied to the project regulation? Why?

2.According to the data obtained from the test,what is its strength grade? Why?

3.Is the normal consistency the necessary index for inspecting cement qulity? What is the purpose of testing it?

VII Questions

1.How should the cement beyond the storage period be dealt with?

2.Should the technical property disqualified cement be treated as waste? Please state your reasons.

(3) Concrete Aggregate---Sand （Basic Experiment: Confirmation）

I Object

To understand how to use sand in making concrete, get familiar with regulations, make proper judges, on the basis of obtained data from the experiments on whether the sand is

qualified to make concrete and the technical and economical effects brought forth by the concrete, to obtain aggregate data needed for making concrete.

II Scientific Principle

Sand grading and fineness can be tested by sieve analysis. Grading can be expressed by grading region. Fineness can be expressed by fineness modulus.

III Instrument and Settings

vibrating screen, counter balance, oven, measuring flask, platform balance, pound scale, vibrating table

Fig.1 vibrating screen

Fig.2 counter balance

IV Methods and Procedures

(i) Aggregate sieving analysis test

1. Put 500g baked sample on the sieve. The sieve should be shaken in the machine about 10 min.
2. Take down the sieve and sieving by hand.
3. Measure each sample remaining quality.
4. Calculation.

fineness modulus μ_f (0.01) .

fineness modulus μf(0.01) .

$$\mu_f = \frac{(A_2 + A_3 + A_4 + A_5 + A_6) - 5A_1}{100 - A_1}$$

（ii）Aggregate approximate density(apparent density) test

Put 300g baked sample (m0) into measuring flask with half volume of cold water and stuff the bottle closure.

Open the flask after 24h and add water to the reticle of the bottle neck with burette and measure the weight(m1).

Pour out the water and sample from the flask and put cold boiled water to the bottle neck reticle. Measure the weight(m2).

Calculate appromixate density(apparent density)pas in the following formula (accuracy to

10kg /m3) ：

$$\rho_{as} = \left(\frac{m_0}{m_0 + m_2 - m_1} - a_t\right) \times 1000 \quad (kg/m^3)$$

（iii）Aggregate stacking density test

Put the sample slowly into cylinder with spoon until it exceeds the cylinder mouth as a taper.

Shave off the extra sample with a ruler in the opposite direction along the center line of the bottle mouth. Measure the total cylinder and sample quality(m2).

Calculate the fine aggregate stacking density ρfs(kg/m3) in the following formula (accuracy to 10kg/m3)：

$$\rho_{fs} = \frac{m_2 - m_1}{V} \times 1000$$

m_1—Cylinder Quality，kg ;

m_2—Cylinder and Sample Quality，kg ;

V— Cylinder Volume， L;

V Data Record and Process

Sand Apparent Density Test

Times	Sample G_0 (g)	Bottle + Sample + Water G_1 (g)	Bottle + Water G_2 (g)	Apparent Density γ_s $\gamma_s = \frac{G_0}{G_0 + G_2 - G_1} (g/cm^3)$

Sand Bulk Density Test

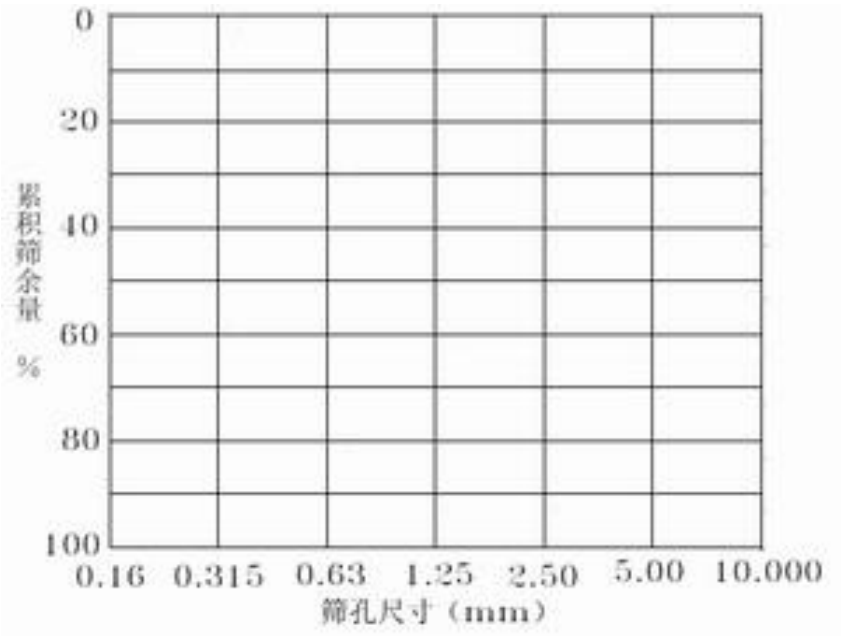
Times	Cylinder Volume (l)	Cylinder Weight (kg)	Sample & Cylinder Weight (kg)	Sample Weight (kg)	Sand Bulk Density (kg/m^3)
			Ave. Bulk Densityyos		

Sand Sieve Analysis Test

Sieve Mesh (mm)	Sieving Remaining Sum		
	Each Share of Sieving Remaining		Sum (%)
	Sieving Remaining (g)	Percentage (%)	

screen bottom			
Fineness Modulus	$M_x = \frac{(A_2 + A_3 + A_4 + A_5 + A_6) - 5A_1}{100 - A_1} =$		
		M_x Grading _____ Grade	

Sand Sieving Curve Graph



Evaluation on the sand grading：_____

Sieve curve in _____ district

(4) Ordinary Concrete（Basic Experiment: Design）

I Objects

To use workability and strength checking methods and test volume;to make and adjust mix proportion design with parameter to improve concrete property.

II Scientific Principle

Design and test concrete mixture making, workability and strength testing by slum; use mix proportion parameter to improve concrete property.

III Instrument and Settings

concrete mixer, slump cone, vebe consistometer test, compression testing machine, bending strength testing machine

Fig.1 concrete mixer, vibrating table, die Fig.2 electron compression machine

Fig.3 slump cone Fig.4 vebe consistometer test

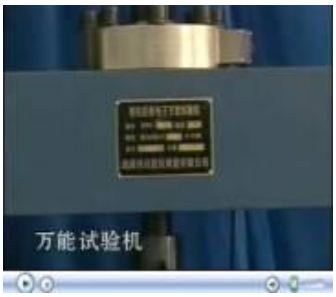


Fig.5 compression testing machine Fig.6 universal testing machine

IV Methods

Design the Experiment.

Select material, calculate concrete mix proportion and design the experiment. The expected concrete properties should be：

Used as reinforced concrete beam(regardless of wind and snow),strength grade C40 with 95% guarantee, slump 30～50mm (machine agitate and shake) .

Carry out the experiment.

Data record and analysis.

Effect analysis on properties by mix proportion.

Hand in the mix proportion and research conclusions.

V Methods for Basic Experiment

For details see the video clip.

VI Data Record and Process(for reference)

（i）Slump

Temperature：_____

Name		Initial Calculation of Material for Making 12 Liter Concrete（kg）	Adjusted Material（kg）	Notes
Cement				
Water				
Sand				
Stone				
Workability	Slump（cm）			
	Viscidity/ Water Retention			

（ii）Measured Apparent density of Concrete Mixture（γoh）

Module Volume（l）	Module Weight（kg）	Sample and Module Weight（kg）	Concrete Mixture Weight（kg）	Measured Apparent Density（kg/m^3）	Ave.（kg/m^3）

（iii）Concrete Compressive Strength Test

No.	Aging days（d）	Compressed Area（mm^2）	Max. Load（N）	Strength（MPa）	Ave. Strength（MPa）	Notes

VII Result analysis and Discussion

Does the concrete made in the experiment meet the designed requirements? Please state your reasons.

What are the factors would affect concrete workability and strength in its Selection, mix proportion design and making process. Please give your analysis on the possible reasons.

Please explain how W/C、Sp and W0 affect concrete properties?

How does the experiment design affect the conclusion?

VIII Questions

Will there be difference in concrete properties if the concrete strength higher or lower? What are the differences?

If concrete is designed for road construction,which strength should be selected and howto make the design?