

CONCRETE



School of Materials Science and Engineering,
Southeast University
Jiangsu Key laboratory of construction
Materials

Pang Chao-ming

Email : pangchao@seu.edu.cn

Qin Hong-gen Zhang Jin-shan Wang Xiu-tian

OUTLINE

- Aim and standard
- General provisions (一般规定)
- Mix proportion (配合比)
- **Properties of freshly mixed concrete (新拌混凝土)** : Mix methods, Slump (坍落度) & density (密度).
- Adjustment of Mix proportion
- **Compressive strength (抗压强度)**

AIM AND ACCORDANCE

➤ Aim:

- Understand the test methods of freshly mixed concrete and compressive strength
- Understand the adjustment of mix properties
- Control the quality of concrete

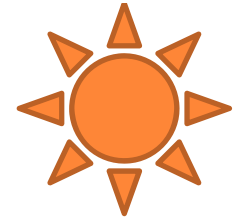
➤ According to

- JGJ 55-2011
- GB/T 50080-2002 fresh concrete
- GB/T 50081-2002 mechanical performance

GENERAL PROVISIONS

- Same temperature of material and environmental before testing ($20 \pm 5^{\circ}\text{C}$)
- Passing a 0.9mm sieve if lump occurs in cement .
- Mix in weight. Accuracy : Aggregate $\pm 0.5\%$, Water, cement, admixture $\pm 0.3\%$.
- Aggregate shall be dry in weight.

SAMPLING (取样)



- The maximum elapsed time between obtaining the final sample and beginning to test shall be **no more than 5min**.
- Sampling position shall be $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$. the maximum allowable time for sampling is **15min**

MIX PROPORTION

Parameters	unit weight/kg/m ³							
	W/C	Sp/%	A%	Water	Cement	Sand	Stone	Admixture
C30	0.52	37	1.0	185	356	688	1171	3.56

T=30~50mm

Sp(砂率)=S/(S+G)

Mix proportion

$$m_{WO} : m_{CO} : m_{SO} : m_{GO} : m_A$$

$$= 185 : 356 : 688 : 1171 : 3.56$$

$$= 0.52 : 1 : 1.93 : 3.29 : 0.010$$

CALCULATE & ADJUSTMENT OF MIX IN LAB

	Unit weight kg/m³	Dry Weight of 10L /kg	sand with 2.0% /kg	adjustment
C	356	3.56	3.56	
W	185	1.85(-0.14)	1.71	
Sand	688	6.88(+0.14)	7.02	
Stone	1171	11.71	11.71	
A	3.56	0.0356	0.0356	
T				
ρ				

- **Mix adjustment : Slump test and Density**
- **Assessment: Compressive strength**

SLUMP (坍落度)

- Apparatus: Mixer (Volume 50~100L), rotating speed: 18~22r/min
- Balance, Graduated cylinder (500mL、1000mL)、shovel and plate.



MIX BY HAND

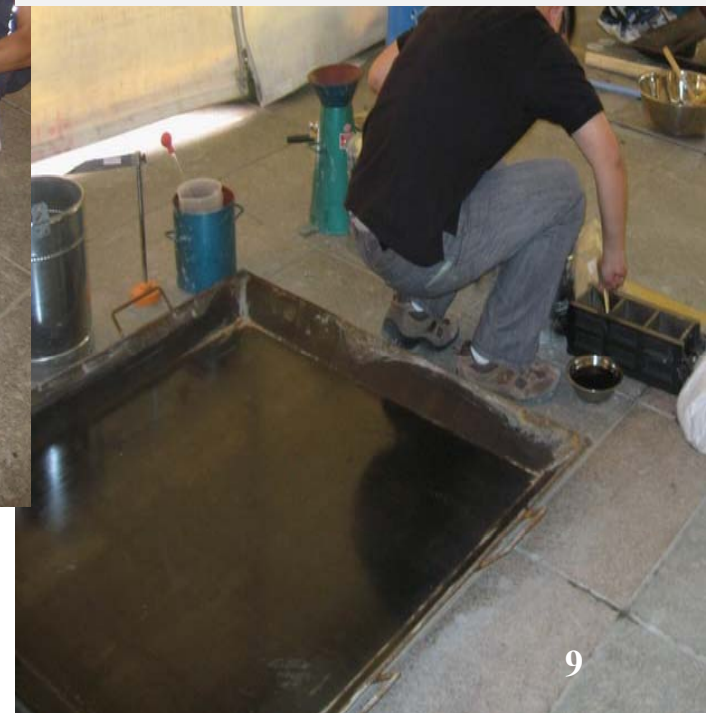
- **Dampen** the shovel, plate & slump cone



- **weighing** in accordance with mix proportions.



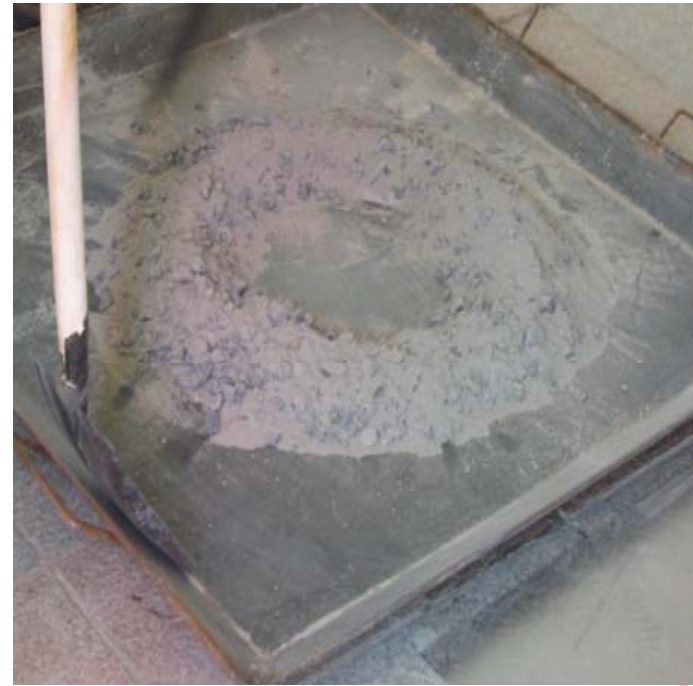
Lightly coated a release oil



- Put the **sand** to plate,
- then add **cement**
- first **mix sand & cement**
- finally **add stone**,
remix uniformly.



- **Stack** up, make a **sunken** in the middle of stack
- pour **half of water** into the sunken, use care to mix. Pour another half of water, continue to mix.
- Time limits: $\leq 30L:4\sim 5min$



MIX BY MIXER

- weighing 。
- Coated with water and cement (刮浆) 。
- Add stone, sand and cement in turn, Dry mix uniformly, then add water, continue to mix no less than 2min but not more than 5min。
- Take out the mixture, then mix 2~3 times by hand
- From start to add the water, all the times shall be within 30min。

CONSISTENCY OF MIXTURE

- Two methods: Max nominal size of aggregate shall be no more than 40mm
 - Slump: plastic or fluid mixture, SI no less than 10mm,
 - V-B consistometer method: Harsh mix, VB=5~30s
- Slump Apparatus: Slump cone. Tamping rod (end rounded to a hemispherical tip), ruler etc.



SLUMP TEST—TEST PROCEDURE

- Dampen (润湿)
- Completing the test shall be within 150s.



Three layers of approximately equal height in each layer with 25 stokes. Throughout its depth and up to the surface of beneath layer.

layer. For the bottom layer, this will necessitate inclining the rod slightly and making approximately half the stokes near the perimeter (out edge), then progressing with vertical strokes spirally toward the center.



5 Immediately after completion of Step 4, the operation of raising the mold shall be performed in 5 ± 2 sec. by a steady upward motion with no lateral or torsional motion imparted to the concrete. The entire operation shall be completed within 10 sec.



Measure the height between the mold and displaced highest top surface of specimen.

Strike-off the surface (抹平) vertically raise the mold in 5~10s.

sample.

SLUMP



- Read slump (T) in terms of mm to the nearest 1mm, Report to nearest 5mm.
- After raise the mold, if the concrete show a falling away or shearing off, repeatedly. If Again, it shows the concrete probably lack necessary plasticity and cohesiveness.

- **Assessment the cohesiveness and water-retaining**
 - **cohesiveness** : **Slightly tap** the side of concrete with tamping rod, if the concrete **gradually submerge**, good; if falling away or shearing, not applicable .
 - **water-retaining**: According to the paste bleeding . If the paste bled and aggregate appear in the bottom ,bad

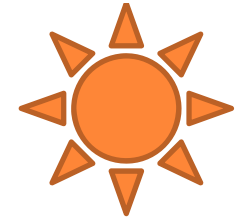


ADJUSTMENT OF WORKABILITY

- For ordinary concrete, $T \leq 90\text{mm}$
 - T is too small, Add 5% ~ 10% cement paste with the same W/C
 - T is too big
 - ◆ If cohesiveness, water-retain is good, Add some sand and stone with the same Sp;
 - ◆ Or else Sp can be changed .

- For high performance, T is big:
- ① Adjusted T by admixture content;
 - ② Adjusted cohesiveness by binder content and S_p
 - ③ Adjusted water-retain by decrease admixture content or increase S_p

NOTES



- Slump decrease with time
- Slump does not measure the water content or workability of concrete.
 - However, an increase or decrease in the water content causes a corresponding change in the slump
- Influences Factors : **aggregate size or grading, mixture proportion, air content, or concrete temperature or the use special admixtures**
 - Result in a change in the water content requirement for maintaining a given slump

DENSITY

➤ Apparatus:

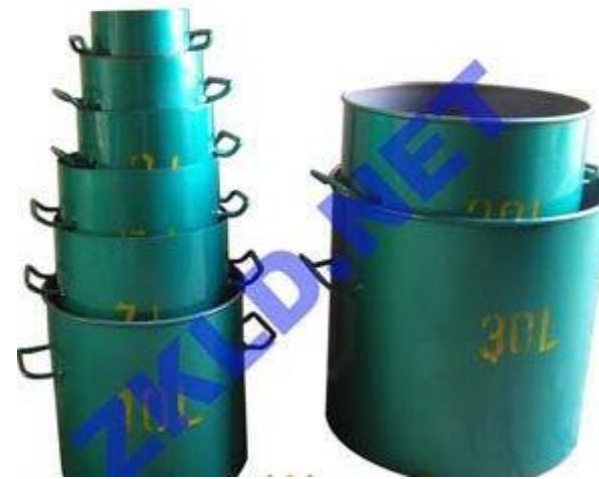
● Container

◆ $D_{\max} \geq 40\text{mm}$: 5L;

◆ $D_{\max} > 40\text{mm}$ Inner diameter and height > 4 times D_{\max} .

● Balance: 50g/50kg.

● Vibrator.



TEST PROCEDURE

- Dampen, weighing (50g)
- Place the concrete, consolidate.
 - $T \geq 70\text{mm}$, vibrator , **fill** , overfill approximately 3mm , Sufficient vibration (smooth or glazed surface) , No air pockets.
 - **>70mm, Use tamping rod**: Two layers, rod 25 times for 5L container (over5L >12 次 /10000mm²) , Tap the side of bowl **5~10 times with the mallet**, release the large bubbles.
- Strike off the top surface , **Cleaning the exterior of bowl**, weighing (50g)



CALCULATION

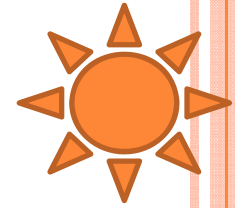
Calculate the density (10kg/m³) :

$$\rho_{oc\text{测}} = \frac{m_2 - m_1}{V} \times 1000 \quad (\text{kg} / \text{m}^3)$$

Where V=5 (L) 。



CORRECTED THE MIX PROPORTION



➤ Correction by density $\rho_{oc\text{计}} = W + C + S + G + A$

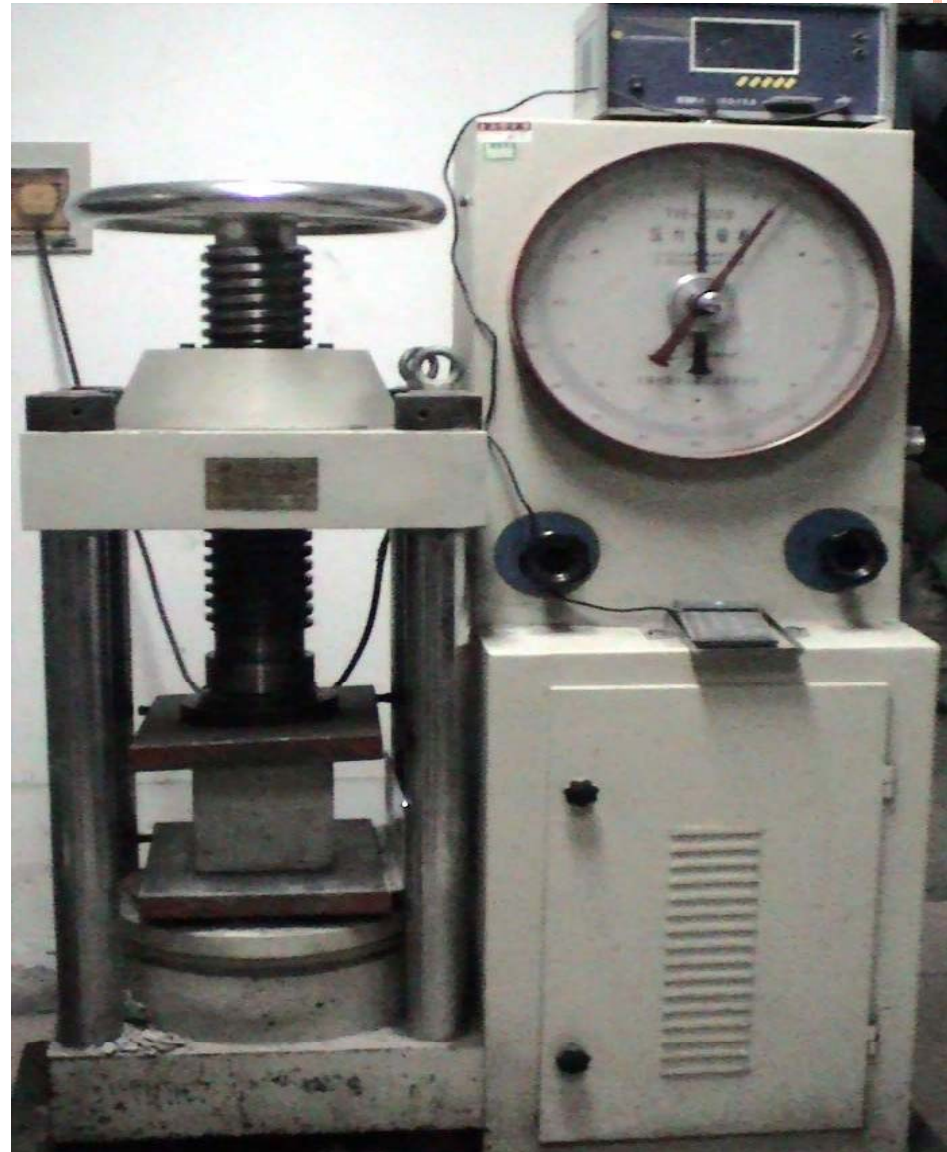
● Correction factor δ $\delta = \rho_{oc\text{测}} / \rho_{oc\text{计}}$

● Two results should differ by less than 2%, No correct.

● More than 2%, unit weight of each raw material **multiplies δ** 。

COMPRESSIVE STRENGTH

- Compressive testor: $\pm 2\%$, 20% ~ 80%;
- Vibrator: $f=50 \pm 3\text{Hz}$, $A=0.5\text{mm}$
- Mixer, shovel, tamping rod, etc.。



MAKING THE SAMPLE

➤ 3 cubic in each age

Nominal size D_{\max} /mm	Size of specimen /mm
31.5	100×100×100
40	150×150×150
63	200×200×200

➤ Lightly coated a release oil, then casting the mold.

➤ Consolidate the mold used the same method of density

- $T \leq 70\text{mm}$: vibrator.
- $T > 70\text{mm}$: tamping rod

CURING

- Standard curing:
 - protected from rapid evaporation by wrapping with plastic, curing 24h at $20 \pm 5^\circ\text{C}$ room, number & demould
- Placed into standard chamber at $T=20 \pm 2^\circ\text{C}$ 、 $\text{RH} > 95\%$, or into Non-flow $\text{Ca}(\text{OH})_2$ saturated solution at $T=20 \pm 2^\circ\text{C}$ until the specified age (28d)。
- The specimen should be put on the shelf, ensure the distance $10 \sim 20\text{mm}$ from specimen to specimen, keep damp and avoid to directly shower with the water

TEST THE COMPRESSIVE STRENGTH

- Clean, measure the size(1mm) , calculate $A(\text{mm}^2)$ 。
- Put the **center** of bearing plate , The bearing surface shall be **vertical** with strike-off surface。
- **Load shall be continuous and uniform**, 加 load rate:
 - $<C30$, $0.3\sim 0.5\text{MPa/s}$;
 - $\geq C30$, $0.5\sim 0.8\text{MPa/s}$ 。
 - $\geq C60$, $0.8\sim 1.0\text{MPa/s}$ 。
- Record the maximum load $P(\text{N})$ 。

CALCULATE TEST RESULTS

- Calculate (MPa) : $f_{cu} = \frac{P}{A} (MPa)$
- Assessment : Take the average of 3 cubic (0.1MPa) 。
 - Take the **middle value**, if the maximum or minimum value $> \pm 10\%$ of the middle value.
 - **Invalidity**, if the maximum and minimum value $> \pm 10\%$ of the middle value.

CORRECTION FACTOR OF SIZE

- Standard cubic: 150mm × 150mm × 150mm
- Other cubic, corrected, C_{60}。
 - 100mm × 100mm × 100mm: 0.95
 - 200mm × 200mm × 200mm: 1.05。

ASSESSMENT OF STRENGTH GRADE

- Strength grade :
 - according to the **standard value of compressive strength of standard cubic of concrete**
 - ◆ **Standard value of compressive strength of standard cubic of concrete** : Making, curing and test by Standard methods, cubic with **150 mm** in length, at **28d** age, With **95%** guaranteed rate (**标准方法制作和养护的边长为150mm的立方体试件, 在28d龄期用标准试验方法测得的具有95%保证率**)。
 - Divided by 5MPa: 15、C20、C25、C30、C35、C40…… C75, C80

EVALUATION OF STRENGTH

- Evaluation of concrete compressive strength
 - GB/T 50107—2010
 - Batch: the compressive strength, mix proportion, and production process shall be the same
- methods
 - statistical methods : $n \geq 10$
 - Non-statistical methods: $n < 10$

END !