

# All-lightweight Aggregate Concrete Frame Structure System of Material Mechanics Performance Test and Research

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**Keywords:** The all-lightweight aggregate concrete; design of the mix proportion; the basic mechanical properties.

**Abstract.** According to the test results of the composition material of the all-lightweight aggregate concrete, design the mix proportion of the all-lightweight aggregate concrete of LC30 and LC35 levels, and make the compressive strength test, the splitting tensile test and the elasticity modulus test, analyze the basic mechanical properties and damage characteristics of the all-lightweight aggregate concrete, play a foundation to design the all-lightweight aggregate concrete frame structure system.

## Introduction

The present Chinese criteria sets the reasonable scope of the density grade of the lightweight aggregate concrete is wider<sup>[1-2]</sup>, and not make the clear requirement. The light concrete as a branch of the lightweight aggregate concrete, is made of light sand as fine aggregate to configure the lightweight aggregate concrete<sup>[3]</sup>, and then to reduce the weight of the structure. To carry out all the research and application of the light concrete has important theoretical basis and engineering value. This topic research the all-lightweight aggregate concrete using shale ceramsite as light coarse aggregate, shale pottery as light aggregate. The apparent density that under the standard condition curing 28 days is less than 1770 kg/m<sup>3</sup>.

## The all-lightweight aggregate concrete mix proportion design

### The main raw material

(1) Ceramsite: The shale ceramsite produced by Light weight building materials factory on Tianjin Wu Tong area, the basic physical performance test results are shown in table 1.

Table 1 The physical and mechanical properties of shale ceramsite

aggregate type	sieve analysis (mm)	bulk density (kg/m <sup>3</sup> )	apparent density (kg/m <sup>3</sup> )	porosity (%)	water absorption (%)	numerical tube pressure (Mpa)
rubble type	5-30	765	820	43	5.6	7.2

(2) Pottery sand: The shale pottery produced by Yi xing wall materials Co. Limited in Nong'an Country of Jilin province, the basic physical performance test results are shown in table 2.

Table 2 The physical and mechanical properties of shale pottery

aggregate type	sieve analysis (mm)	bulk density (kg/m <sup>3</sup> )	apparent density (kg/m <sup>3</sup> )	porosity (%)	water absorption (%)	numerical tube pressure (Mpa)
ball type	3-4	480	770	38	11.2	3.6

(3) Cement: Changchun local brand P.O 42.5 cement.

(4) Admixtures: The fly ash, water reducing admixture.

### The all-lightweight aggregate concrete mix proportion design

There are many factors can affect the all-lightweight aggregate concrete performance and strength, such as the strength of light coarse aggregate and light fine aggregate, cement strength, water cement ratio, cement content, etc. Among them, the strength of light weight aggregate on the lightweight concrete strength plays a main role. Therefore, a reasonable mix proportion design, can not only give full play to The characteristics of the lightweight aggregate is light, but also can reduce the defects of low intensity<sup>[4]</sup>, that due to the material itself reflects the light and porous. Through the orthogonal test, to explore the strength grade most a ccurately LC30 and LC35 levels of the light concrete mix proportion design. The orthogonal test are shown in table 3, comparative analysis is shown in Fig. 1.

Table 3 The mixture ratio of full lightweight aggregate concrete

number	cement ( kg )	ceramsite ( kg )	pottery sand ( kg )	the fly ash (kg)	water reducing admixture ( % )	W/C	strength ( Mpa )
P1	100	120	60	10	0.75	0.4	37.2
P2	100	100	60	10	0.75	0.4	35.5
P3	100	80	60	10	0.75	0.4	32.2
P4	100	120	50	10	0.75	0.4	36.7
P5	100	100	50	10	0.75	0.4	34.5
P6	100	80	50	10	0.75	0.4	31.8
P7	100	120	60	30	0.75	0.4	37.1
P8	100	100	60	30	0.75	0.4	35.7
P9	100	80	60	30	0.75	0.4	33.6

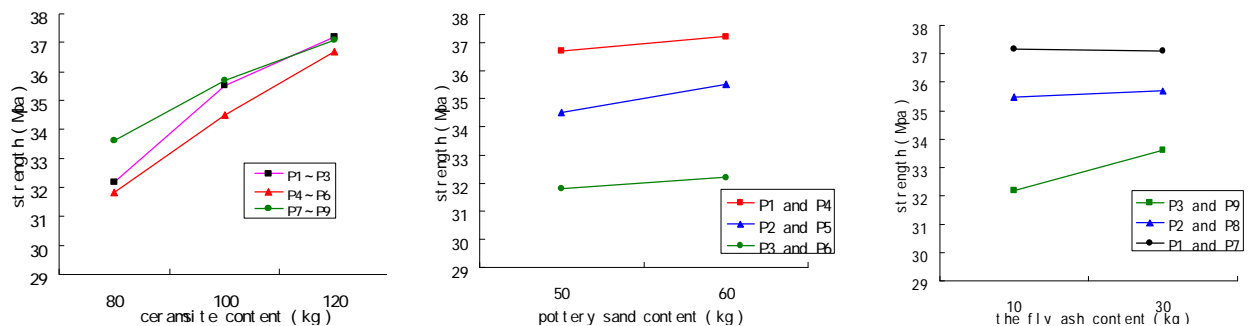


Fig.1. Comparative analysis of the test results

Fig.1 shows that under the condition of cement dosage, water cement ratio and admixtures of the same, ceramsite content reduced, the all-lightweight aggregate concrete strength decreases; pottery sand content reduced, the all-lightweight aggregate concrete strength decreases; The fly ash content has no obvious effect on strength. According to the test results determine LC30 and LC35 levels optimal mixture ratio of the all-lightweight aggregate concrete, shown in table 4.

Table 4 The optimal mixture ratio of concrete LC30 and LC35 levels

strength grade	cement ( kg )	ceramsite ( kg )	pottery sand ( kg )	the fly ash ( kg )	water reducing	W/C
LC30	100	80	50	30	0.75	0.4
LC35	100	100	60	10	0.75	0.4

## The basic mechanics performance test and research of the all-lightweight aggregate concrete

### The Dry apparent density and the compressive strength test and research of the all-lightweight aggregate concrete

According to LC30 and LC35 levels of the all-lightweight aggregate concrete mix proportion design, on the basis of the existing specification test method, the dry apparent density and compressive strength test of LC30 and LC35 level of the all-lightweight aggregate concrete are shown in table 5, failure mode is shown in Fig.2.

Table 5 The dry apparent density and compressive strength test of LC30 and LC35 levels

strength grade	name	1	2	3	4	5	6	average
LC30	dry apparent density (kg/m <sup>3</sup> )	1704	1730	1718	1721	1729	1700	1717
LC35		1739	1751	1771	1780	1788	1767	1766
LC30	cube compressive strength (Mpa)	32.1	31.3	33.6	33.1	32.7	34.0	32.8
LC35		36.1	37.1	36.9	37.9	38.6	36.6	37.2

### Splitting and tensile strength tests and researches of the all-lightweight aggregate concrete

For the experiment research of the LC30 and LC35 level of the all-lightweight aggregate concrete, do splitting and tensile strength tests. Tests results are shown in table 6, failure mode is shown in Fig.3.

Table 6 The splitting and tensile strength tests of LC30 and LC35 levels

strength grade	splitting and tensile strength ( Mpa )			average ( Mpa )
LC30	1.8	1.98	1.85	1.88
LC35	2.03	2.44	1.96	2.14

### The elasticity modulus test and research of the all-lightweight aggregate concrete

Testing the elasticity modulus, respectively, of the all-lightweight aggregate concrete, test results



Fig.2. The compressive strength test of full lightweight aggregate concrete



Fig.3. The cleavage strength test of full lightweight aggregate concrete



Fig.4. The elastic modulus test of full lightweight aggregate concrete

are shown in table 7, failure mode is shown in Fig.4.

Table 7 the elasticity modulus test results of LC30 and LC35 levels

strength grade	the elasticity modulus ( $\times 10^4$ MPa )			average ( $\times 10^4$ MPa )
LC30	1.71	1.78	1.73	1.74
LC35	1.83	1.84	1.76	1.81

## Conclusions

(1) Through the reasonable proportion and trial and error, eventually researched the good

mechanical properties of LC30 and LC35 level of the all-lightweight aggregate concrete,for the all-lightweight aggregate concrete frame beam-column joints seismic test provides reasonable proportion of the all-lightweight aggregate concrete.

(2)For the experiment research of the LC30 and LC35 level of the all-lightweight aggregate concrete,do the compressive strength test,splitting and tensile strength tests,and he elasticity modulus test.analysis the basic mechanical performance and failure characteristics of the all-lightweight aggregate concrete,for the all-lightweight aggregate concrete frame beam-column joints seismic test provides theoretical basis.The test shows that,the all-lightweight aggregate concrete sets load bearing,energy saving and Insulation in one lightweight construction materials,it can effectively reduce the project cost and the aseismic effect.

(3)Due to the strength and the elasticity modulus of the lightweight aggregate is less than the cement mortar,between the rough surface of the lightweight aggregate and the cement mortar,the cohesive force is strong and some reasons lead to the all-lightweight aggregate concrete is not easy to happen interface damage<sup>[5]</sup>.The test shows that,the all-lightweight aggregate concrete failure mode is aggregate cracking damage.

### **Acknowledgements**

This work was financially supported by the Jilin Science and Technology Foundation (20150203014SF, 2012200, 2015267).

The authors gratefully acknowledge the Natural Science Foundation of China (No.51378238).

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