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ANSYS Analysis of Prefabricated Light Aggregate Concrete Slab with Grouting

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Abstract. In this paper, through the relevant references of grouted concrete slabs, combined with the comparative analysis of lightweight aggregate concrete, a kind of "grouted assembled lightweight aggregate concrete slabs" is proposed. And design the size and reinforcement of prefabricated slabs. The mix ratio of lightweight aggregate concrete is calculated. The normal section bearing capacity of lightweight aggregate concrete slabs is calculated by theoretical formula.Combining with ANSYS software,get the analysis and comparison. According to the construction technology, four key quality control points and flow chart are put forward.,which provides a deep reference for the construction of the assembled lightweight aggregate concrete slab with core filling in the future.

1. Introduction

With the development of urbanization in China, the supply of housing market is difficult to meet the requirements for a while, and the quality of construction has not kept up with the normative requirements. Therefore, housing industrialization, standardization and assembly integration of construction have become the general trend. At the National Conference on housing construction in urban and rural areas held at the end of 2015, eight key tasks of the Ministry of Housing and Construction after 2016 have been determined, which conveys the new trend of future urban development and promotes the breakthrough progress of assembly buildings. [1] Being listed as a separate item, the development of assembled concrete slabs is also an important link. Experts and scholars at home and abroad have done a lot of experimental research on assembled concrete slabs. Poland adopts DMSZ as the floor of composite structural components, i.e. prefabricated concrete is placed in the pre-stressed trabecula of assembled load-bearing structures, and hollow concrete blocks are poured on the precast concrete to make the three work together. Britain adopts the "Shtal House" system as the composite structure.After placing hollow concrete blocks on the beam-type assembling bearing parts, concrete is poured on to form a whole. The beam-type assembling bearing parts are specially designed composite floor slabs with grid-hooked reinforcement applied to the pre-German West Wade concrete prefabricated floor. Recently, China has also invented the "core-filled assembling concrete slabs", especially the "core-filled assembling concrete slabs". Professor Meng Fanlin of Jilin University of Architecture proposed the grouted assembled concrete slab [2-5]. The grouted assembled concrete slab is a new type of assembled concrete slab. It means that the factory prefabricated transverse hollow concrete strip slab is spliced at the construction site, and the transverse perforated steel bar, bearing negative steel bar and joint steel bar are arranged, then the hollow part of the concrete filled slab is poured, thus forming a hollow part of the concrete filled slab. While meeting the strength and other performance requirements, the integral lightweight aggregate concrete under

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common loading can reduce the self weight, reduce the elastic modulus,make the aggregate and mortar have good rutting performance, reduce the cost and reduce the difficulty of assembly site hoisting construction. The concrete slab is taken as the research object. The bearing capacity and failure characteristics of the prefabricated lightweight aggregate concrete slab are compared and analyzed by means of the finite element software. The structure reinforcement mm is adopted, and the negative bending moment reinforcement is arranged on the top of the groove reserved on the top of the prefabricated transverse hollow concrete slab, and the "light aggregate grouted prefabricated concrete slab" is innovated.

2. Test content and method

2.1. Test material design

Cement: PO42.5 Ordinary Portland Cement is produced in Panshi City Jilin Province Jidong Cement Panshi Co., Ltd.Natural fine aggregate: particle size of 5mm below the Yanji River sand.Natural fine aggregate: Yanji River sand with a particle size of 5 mm or less. Flyash: from Yanji County, Jilin Province, the production of Guodian longhua thermal power company.Water: Yanji running water.

2.2. Material preparation

A total of test pieces were produced in this article: 1500mm×300mm×100mm Irrigation Assembled Lightweight Aggregate Concrete Slab,Slump :30-50mm. According to the light aggregate test, it was carried out in accordance with the "light aggregate and its test method" GB/T17431 12-1998 [6]; lightweight aggregate concrete according to the "lightweight aggregate concrete test procedure" JGJ 51-2002 [7].

3. LIGHTWEIGHT AGGREGATE CONCRETE MIX DESIGN

When the strength is CL30 and the density class is 1600Kg/m^3, when the mix proportion of lightweight aggregate concrete slab is designed, the amount of each material is calculated according to the light aggregate concrete formula shown in Table 1, the slump requirement is 30-50mm, and the pulverized coal is Gray ceramic particles in the large powder particle size of 15mm, light coarse aggregate dry apparent density of 1050Kg/m^3 cylinder compressive strength of 4.0MPa, 1h water absorption rate of 16%; natural sand density of 2600Kg/m^3 other parameters based on Specification "Lightweight aggregate concrete technical specification" JGJ51-2002 [8].To sum up, the theoretical mix ratio of core assembled lightweight aggregate concrete slab is: m_c:m_w:m_s:m_a=1:0.53:0.66:1.19

Table 1. Calculation formula for mix ratio of lightweight aggregate concrete

Formula code	Name	Formula
（1）	Compounding strength of concrete	$f_{cu,0} = f_{cu,k} + 1.645\sigma$
（2）	The formula of the volume of sand	$V_s = [1-(\frac{m_c}{\rho_c}+\frac{m_w}{\rho_w})]$
（3）	The quality formula of sand	$m_s = V_s \times \rho_s \times 1000$
（4）	Volume formula of coarse aggregate	$V_a = [1-(\frac{m_c}{\rho_c}+\frac{m_w}{\rho_w}+\frac{m_s}{\rho_s})]$
（5）	Quality formula of coarse aggregate	$m_a = V_a \rho_{ap}$
（6）	Rechecking the density of lightweight aggregate concrete	$\rho_{cd} = 1.15 \times \mathrm{m_c} + m_b + m_a$

4. COMPONENT DIAGRAM DESIGN

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The plane and section of the cored assembled lightweight aggregate concrete slab are shown in Figure 1~Figure 5.

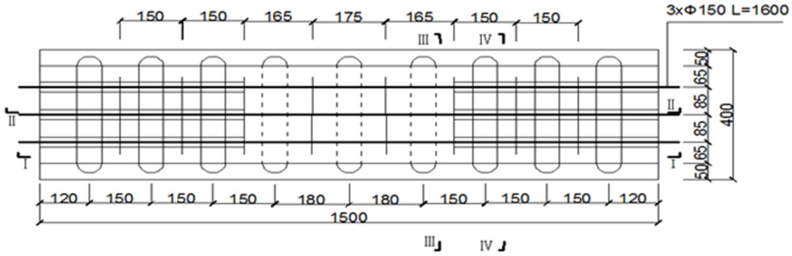

Figure 1.Layout of lightweight aggregate concrete slab with core assembly

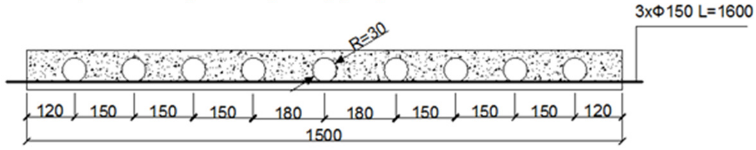

Figure 2. 1-1 profile

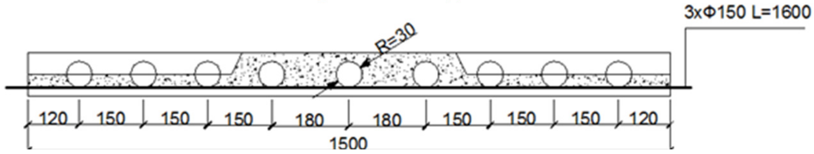

Figure 3. 2-2 profile

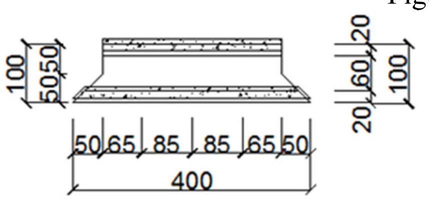

Figure 4. 3-3 profile

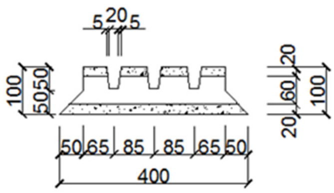

Figure 5. 4-4 profile

5. ANSYS finite element analysis

This structure adopts the integral model of SOLID65 element and distributes reinforcing bars in the whole element. It is assumed that concrete and reinforcing bars are well bonded and the element is regarded as a continuous uniform material. The finite element model of light aggregate prefabricated slab with core filling is shown in Fig. 6 and Fig. 7. Because this prefabricated slab model does not belong to regular 6-hedral and 4-hedral elements, mapping grid generation and Sweep grid generation can not be used. Intelligent grid generation is used in this analysis. Mesh grid generation can be seen in this analysis.

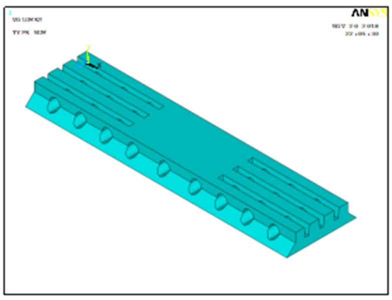

Figure 6. Finite element model of grouted prefabricated concrete slab

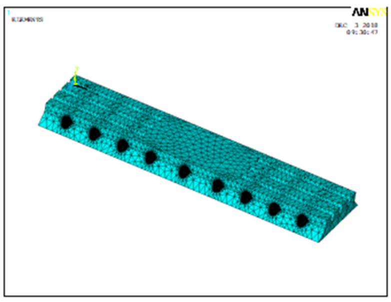

Figure 7. Mesh generation of grouted prefabricated concrete slabs

From the stress nephogram of ordinary concrete and lightweight aggregate concrete, it can be seen that the maximum stress in coagulation mainly distributes in the range of no reserved groove on the top of the mid-span slab. At the same time, the maximum stress on the top of the slab is close to the ultimate compressive stress on the coagulation, and there is no crushing on the coagulation in the compression zone, which accords with the characteristics of the slab.

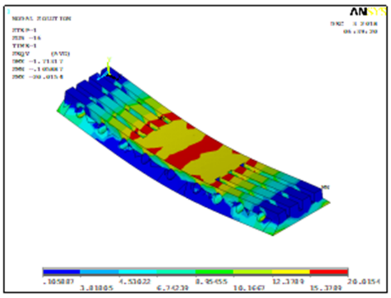

Figure 8. Equivalent Stress Diagram of Ordinary Concrete Prefabricated Slab

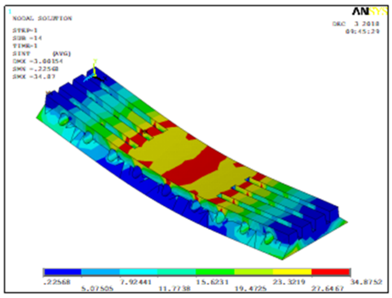

Figure 9. Influence of steel fiber spreading layer on cube compressive strength

6. CALCULATION OF NORMAL SECTION BEARING CAPACITY OF CORE ASSEMBLED LIGHTWEIGHT AGGREGATE CONCRETE SLAB

According to the study of bending members with row-wise circular holes [9], the assumption of flat section can be applied to the average strain in the length and longitudinal section of a member, so the strain at the pier center of the precast plate filled with cored lightweight aggregate conforms to the assumption of flat section; according to the study of honeycomb beams on reinforced concrete, when the net distance between holes of honeycomb beams exceeds 1.5 times the diameter of circular holes. Above all, the deflection of the beam is close to that of the solid web beam, and the distribution of the normal stress of the beam section tends to be linear with the increase of the ratio, so the bearing capacity of the prefabricated slab is reduced by the influence of the reserved circular holes.

Table 2. Calculation formula of normal section bearing capacity of ordinary concrete

Formula code	Name	Formula
(1)	Pressure area height	$\alpha_1 f_c bx = f_y A_s$
(2)	Calculation bearing capacity of positive section	$M = \alpha_1 f_c bx(h_o - \frac{x}{2})$
(3)	Effective height of cross section	$h_0 = h - a_s$

7. KEY POINTS OF QUALITY CONTROL

In order to ensure the quality of the construction, 4 key points of quality control are put forward, "whether the cement slurry is painted well", "checking the bar binding is in line with the requirements", "whether the reinforced bar is in line with the requirements" and "whether the model meets the requirements of the regulations" and draw the construction flow chart.

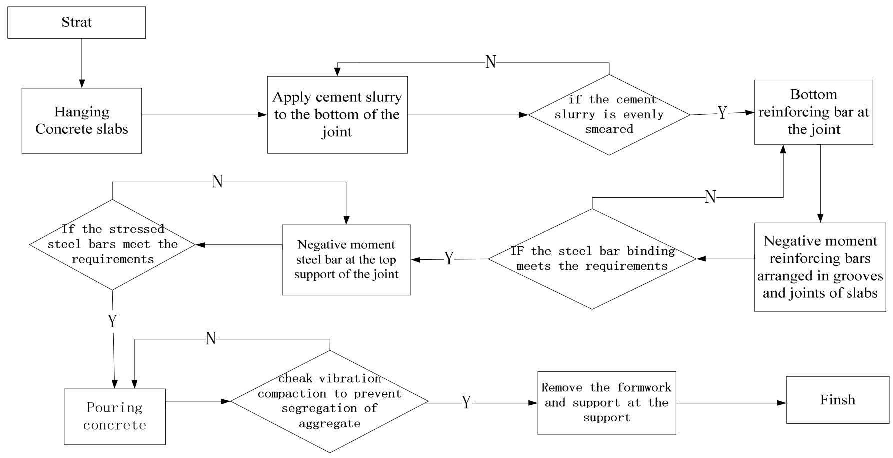

Figure 10. Construction flow chart of filled assembled lightweight aggregate concrete slab

8. CONCLUSIONS

(1) Through comparative analysis, a kind of filling lightweight aggregate concrete slab is put forward, and the prefabricated slab is simulated by ANSYS finite element method. The maximum stress in coagulation is mainly distributed in the range of no reserved groove on the top of the mid-span slab. At the same time, the maximum stress on the top of the slab is close to the ultimate compressive stress on the top of the coagulation, and there is no coagulation on the compressive zone.

(2) The construction flow chart is put forward, and four key points of quality control are put forward to calibrate on-site construction, which can provide reference for on-site construction.

(3) In this paper, the normal section formula of ordinary concrete code is used to calculate, and the ANSYS software should be used to simulate the comparison and analysis, and a calculation formula of the normal section of lightweight aggregate-filled concrete slab is obtained.

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