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Model for compaction density and engineering properties of light weight soil

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Abstract: In order to study the compaction mechanism of soft inclusion soil, and to guide the prescription design and compaction construction of light weight soil, a model for compaction density is established based on material composition and the physical essence of soil compaction. It is found that the predicted value is nearly close to the measured wet density. The absolute error is only 0.003～0.051 g/cm^3, and the relative error is only 0.282%～5.267%. It is proved that the model for compaction density can predict exactly the wet density of mixed soil under different compaction conditions. The compression ratio of EPS beads and the wet density of mixed soil increase with the increase of compaction times, and the increase trend becomes slow gradually, and the void ratio of mixed soil decreases with the increase of compaction times. Under compaction conditions, the increase of wet density of light weight soil is accomplished by both the deceasing pore of soil and the plastic compression of EPS beads soft inclusion. Being similar to those of light weight soil with sand, the wet density and unconfined compressive strength of light weight soil with clay increase with the increasing compaction times. When compaction time n=25, the compression ratio range of EPS beads is 6.13%～11.51%; when n=94, the compression ratio range is 12.80%～14.87%. It is proved that the compaction times and energy which the standard specifies are fit for the compaction of mixed soil, and will not destroy the EPS beads. Considering that the measuring process of the parameters for the model for compaction density is complex, according to the practical engineering situation, it is supposed that the water content keeps the same during the compaction process, and the holes between soil and EPS beads after compaction are close to 0. The simplified model for compaction density is put forward, and the fact that the simplified model can be fit for the practical projects completely is proved.

Key words: light weight soil; compaction density model; wet density; unconfined compressive strength; compression ratio; compaction times

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轻量土击实密度模型与工程特性

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摘 要：为了探索软夹杂土体压实机理，指导轻量土配方设计与压实施工，基于混合土物质结构组成及土体压缩变密的物理本质，建立了击实密度模型。试验发现模型预测值与实测湿密度基本一致，绝对误差仅有 0.003～0.051 g/cm^3，相对误差仅有 0.282%～5.267%，证明击实密度模型可以准确预测混合土不同击实条件下的湿密度。EPS 颗粒压缩率、混合土湿密度随击实次数增大而增大，增大趋势逐渐变缓；混合土孔隙比随击实次数增大而减小。在击实作用下，轻量土湿密度的提高是由土体的孔隙减少和 EPS 颗粒软夹杂的塑性压缩共同完成的。与砂土轻量土性质相似，粘土轻量土的湿密度、无侧限抗压强度随击实次数增大而增大。n=25 击时，EPS 颗粒压缩率范围 6.13%～11.51%；n=94 击时，EPS 颗粒压缩率范围 12.80%～14.87%。证明规范规定的击实次数与击实能量适合混合土的击实，不会导致 EPS 颗粒消泡。考虑到击实密度模型参数测定非常繁琐，根据工程实际情况，假设压实过程中土料含水量不变与压实后土颗粒-EPS 颗粒之间的孔隙近似为 0，进一步提出了简化击实密度模型，并且通过试验证明了简化模型完全适用于实际工程。

关键词：轻量土；击实密度模型；湿密度；无侧限抗压强度；压缩率；击实次数

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0 Introduction

Japan is an island country surrounded with water, and there is widely distributed soft soil ground around it. The conventional solution methods hardly treat soft soil ground due to its abundant water content, weak anti-shear ability, great compressibility, long consolidation time and so on. Under the situation of deep soft layer, even though some ground treatments have been done before, the long-time deformation could occur in ground in the future, and the ground may lose its overall stability or partial stability. For the soft soil ground problems, the Japanese scholars and engineers developed foamed particle light weight soil and foam mixture light weight soil in the 1980s, which had an epoch-making significance for ground treatment. For thousand of years, the people have been dealing with geotechnical engineering problems and exploring some new ground treatment methods to meet the needs of engineering design and construction. In conclusion, there are four soil improvement theories for different ground treatment methods: dry hard reinforcement theory, compaction reinforcement theory, cementation reinforcement theory, and reinforced earth theory. Light weight soil has broken the traditional methods of soil improvement, and its most special characteristics are light weight, high strength, adjustable properties of strength and density.

Light weight soil originates in soft soil ground treatment, but in fact it can be used in lots of projects, such as road widening, slope repairing, culvert backfill, tunnel entrance excavation and restoration, backfill at road-bridge transition section, narrow space filling, and so on[1-5]. There are usually two construction methods for mixed soil: roller compaction method (or dynamic compaction, vibration compaction, squeeze compaction method) and pouring method. Because sludge and muddy soil have high water content, there are lots of research achievements in fluidity of light weight soil and its construction data[6-10], while there are few research achievements in its roller compaction construction data. If the roller compaction method is used, it will relate to optimum water content and roller compaction density[11-12]. The standard compaction test[13], which could be divided into light compaction test (3 layers, 25 hits for each layer) and heavy compaction test (3 layers, 94 hits for each layer), is usually used in the laboratory to simulate the dynamic behavior of site rolling and tamping. In order to prepare some samples easily, sometimes minitype compaction test (use triaxial compaction apparatus to make some samples, mold: h=8 cm, d=3.91 cm) is used to replace the standard compaction test. The minitype compaction test can also be divided into light compaction test and heavy compaction test. According to the unit volume power conversion, if the sample is made with 3 layers, light compaction test has 25 hits for each layer, and heavy compaction test has 94 hits for each layer. Some compaction laws are found in the minitype compaction tests carried out by LI Ming-dong[4]: dry density, unconfined compressive strength, cohesion and internal friction angle increase with the increasing compaction times, and then the increase trend become stable gradually. They also increase with the increased compaction energy, but the increase rate isn’t steady in the last. And some empirical formulae are put forward to calculate dry density and unconfined compressive strength of light weight soil. Then, a compaction model for dry density is established for mixed soil[15]. But there are still three problems: (1) The enhancing of compaction times or compaction energy can increase the density and strength of mixed soil. However, if they are over-compacted, EPS beads will be damaged or even destroyed. The strength of mixed soil indeed increases, but the density is also enhanced at the same time. That is against the original intention of light weight soil. LI Ming-dong's experimental results are based on compaction times of 1～16, which is far less than the compaction times the standard requires for light or heavy compaction test. Can the standard be fit for research on light weight soil? (2) Compaction characteristics of light weight soil with sand are studied by LI Ming-dong. What is about the characteristics of light weight soil with clay? (3) As for site construction, mixed ratio experiments have to be done to decide optimized prescription based on strength and wet density of mixed soil. LI Ming-dong's dry density model isn’t convenient for site construction. Meanwhile, it has been found that ideal density model[16-17] cannot predict wet density accurately. Can wet density of mixed soil be accurately predicted?

Based on material composition of mixed soil and the decrease of soil pore and the compression of EPS beads under compaction load, a model for compaction density of light weight soil is established. According to lots of laboratory tests, the model applicability is tested, then the feasibility of research on mixed soil using the standard is explored. After that the basic characteristics of light weight soil with clay are investigated.

1 Model for compaction density of light weight soil

Based on the traditional compaction theory, the soil particle itself cannot be compacted, and soil compression is the result of decreasing pore. However, there are raw soil, curing agent, light material, water and admixture in light weight soil, so the compaction of soft inclusion soil is much complicated than that of the ordinary soil. The increasing density is not only from the decrease of internal pore, but also from the plasticity compression of soft inclusion beads itself. The ideal density model cannot consider the compression of EPS beads itself, so it cannot predict the wet density with different compaction times (or compaction energy). No matter what theory is used for strengthening soil, the soil has to obtain high density. If the light weight soil is over-rolled or tamped, EPS beads will be destroyed and the density of mixed soil will increase greatly. So compaction energy should be properly controlled to make sure that the soil can get as high density and strength as possible, and the EPS beads cannot be over-compressed.

In order to simplify the problem, it is supposed that there is only physical mixture, but no chemical reaction between different compositions in the mixed soil. Some conclusions can be drawn from Fig. 1, and there are five parts in light weight soil: soil particles (m_s represents its mass, v_s represents its volume), cement (m_c represents its mass, v_c represents its volume), water (m_w represents its mass, v_w represents its volume), EPS beads (m_e represents its mass, v_e represents its volume), and air (its mass is equal to 0, v_a represents its volume). After compaction, some parameters change to others: the mass of the water in mixed soil is m_{w1}, its volume is v_{w1}, and the water content after compaction is w_1; the volume of pure particles of EPS beads after compression is v_{e1}; the volume of the air in mixed soil is v_{a1} (the remaining air in the interior of EPS can be ignored); the void ratio of mixed soil is e_1, and the volume of the sample is v_1, and t_e is the compression ratio of EPS beads.

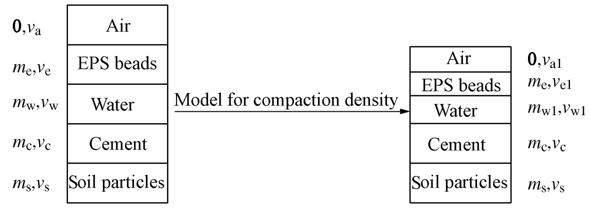


Fig. 1 Sketch map of model for compaction density

Air volume after compaction:

$$v_{a1} = v_1 - v_s - v_c - v_{w1} - v_{e1} \quad , \tag{1}$$

Volume of EPS beads after compaction:

$$v_{e1} = v_e(1 - t_e) \quad , \tag{2}$$

Void ratio after compaction:

$$e_1 = \frac{v_{a1} + v_{w1}}{v_s + v_c + v_{e1}} \quad , \tag{3}$$

Wet density of light weight soil after compaction:

$$\rho = \frac{m_s + m_c + m_{w1} + m_e}{v_s + v_c + v_{w1} + v_{e1} + v_{a1}} \quad , \tag{4}$$

Combining (1) and (4), one obtains:

$$\rho = \frac{m_s + m_c + m_{w1} + m_e}{\left[\frac{m_s}{\rho_s} + \frac{m_c}{\rho_c} + \frac{m_e}{\rho_e}(1 - t_e)\right](1 + e_1)} \quad , \tag{5}$$

Numerator and denominator in Equation (5) divided by m_s yield:

$$\rho = \frac{1 + a_c + w_1 + a_e}{\left[\frac{1}{\rho_s} + \frac{a_c}{\rho_c} + \frac{a_e}{\rho_e}(1 - t_e)\right](1 + e_1)} \quad . \tag{6}$$

In Equation (6): with the mass of dry soil (m_s) as a standard, a_c represents cement mixed ratio (it indicates the cement mass in dry soil of 100 g, and it is a mass percent), a_e represents mixed ratio of EPS beads; ρ_s represents relative density of soil particles, ρ_c represents relative density of cement particles, ρ_e represents density of pure particles of EPS beads. Equation (6) is the wet density model of light weight soil under compaction conditions. What we need to do is just to measure the water content of mixed soil, the compression ratio of EPS beads and void ratio after compaction.

2 Model tests and experimental contents

2.1 Experimental materials and preparation of samples

Light weight soil with clay: the soil fetched from a foundation pit (depth: 5 m) near Guanshan Supermarket in Wuchang City is a typical Guanshan clay. The colour

Table 1 Basic physical parameters of clay

Natural density ρ /(g·cm^{-3})	Specific gravity G_s	Water content w /%	Plastic limit w_p /%	Liquid limit w_L /%	Plasticity index I_p /%	Liquidity index I_L	Bulk density r /(kN·m^{-3})	Void ratio e	Optimum water content w_{op} /%
2.055	2.73	20.20	21.88	39.36	17.49	−0.096	20.55	0.597	23.0

of the clay is deep yellow and a little red. It has a high iron content, and it's very hard. Its basic physical parameters are shown in Table 1. Dry the soil first, then crush it, after that put it into the sieve (it has quite a few 1 mm-diameter holes) and sway the sieve to filter some debris and gravels. Light weight materials are EPS beads with a diameter of 2～3 mm. Its density of pure particles is 0.038 g/cm^3, and its packing density is 0.025 g/cm^3. The cement is 32.5 composite Portland cement (Huaxin fort brand), and it is produced by Huaxin Cement Co., Ltd. The water is ordinary tap water.

Light weight soil with sand: dry the sand first, then put it into the sieve (it has quite a few 2 mm-diameter holes) to filter some debris. It is a medium sand, its packing density after vibration is 1.59 g/cm^3, and its relative density is 2.67. Some conclusions can be drawn from Fig. 2: nonuniform coefficient of the sand (c_u) is equal to 3.8, its curvature coefficient (c_c) is equal to 1.00, and it is poorly graded. The other materials are the same as above.

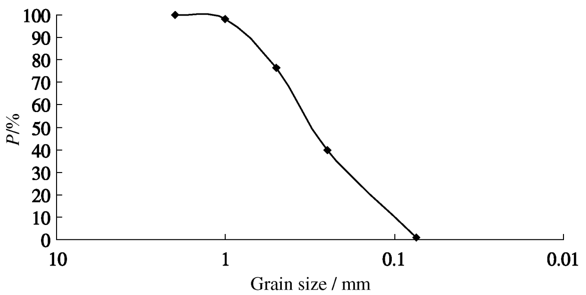


Fig. 2 Cumulative curve of size grading for medium sand

The sample preparation methods for the two types of light weight soil are the same, and concrete contents are presented in Reference [12]. Put the samples with three-segment-die into the standard curing box, curing temperature is 20±2℃, and curing humidity is ＞95%. 24 h later, take off three-segment-die, put the samples into preservative film immediately and seal it up, and then keep the samples in the standard curing box again for 7 days. There is no cement in light weight soil with sand, which should be tested directly after preparation.

2.2 Test contents

(1) Inspection schemes for model for compaction density

Test methods: pour some water into the dry sand (w =15%), mix them homogeneously, then put EPS beads into the mixture and stir them again. Cover a layer of preservative film on the inner surface of the mold, weigh some mixed soil, and fill the mixed soil into the mold with three layers. The samples are made using the layered compaction method. When the samples are all prepared, measure their volume (v_1) directly, then measure the water mass (m_{w_1}) after compaction by oven drying method (48 h, 60 ℃). As is shown in Fig. 3, put the samples into the container which is filled with some water, it is apparent that the sand will sink and the EPS beads will float rapidly. Then collect the EPS beads, and measure its volume after compaction (v_{e1}) by drainage method[16]. The EPS beads after different compaction times are shown in Fig. 4. Collect the sand at the bottom of the container, then dry it, after that measure its mass (m_s) by oven drying method. The parameters of light weight soil before and after compaction are the same as the ones in the model, but it has no cement parameters here.

Fig. 3 Volume of EPS beads measured by drainage method

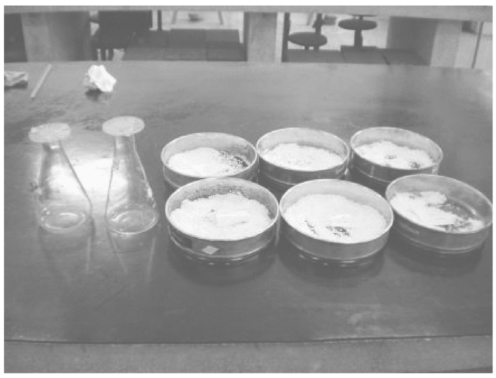


Fig. 4 EPS beads after different compaction times

Table 2 Inspection schemes for model for compaction density

Item	Raw soil	Water content before compaction w /%	EPS mixed ratio a_e/% (EPS volume ratio b_e/%)	Compaction times n
Scheme 1	Medium sand	15	1（33.41）	25，50，94
Scheme 2	Medium sand	15	3（60.08）	25，50，94

Table 3 Test schemes

Item	Cement mixed ratio a_c/%	EPS mixed ratio a_e/% (EPS volume ratio b_e/%)	Water content w /%	Age T /d	Compaction times n
Scheme 1	15	3 (about 50)	30	7	25，50，94
Scheme 2	15	3 (about 50)	37	7	25，50，94
Scheme 3	15	3 (about 50)	48	7	25，50，94

The water content of mixed soil after compaction:

$$w_1 = \frac{m_{w_1}}{m_s} \quad , \tag{7}$$

Compression ratio of EPS beads:

$$t_e = \frac{v_e - v_{e1}}{v_e} \quad , \tag{8}$$

Void ratio after compaction:

$$e_1 = \frac{v_1 - \dfrac{m_s}{\rho_s} - v_{e1}}{\dfrac{m_s}{\rho_s} + v_{e1}} \quad . \tag{9}$$

The experimental schemes are shown in Table 2. The volume ratio of EPS beads (b_e) is defined as follows: b_e = (volume of pure EPS beads /total volume of mixed soil)×100%.

(2) Experimental schemes for physical mechanical characteristics of light weight soil with clay under compaction

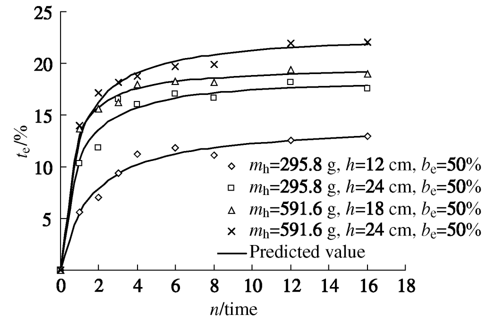
After fetching from the curing box, wet density test should be done directly according to the standard[13], then unconfined compressive strength test should be conducted. There are three samples for each mixed ratio, and take the average value as the relevant value of density and strength. The density can be measured by vernier caliper and electronic balance (2000 g). The strength can be tested by the strain-tpye unconfined compressive apparatus made in Nanjing Soil Instrument Factory, whose strain rate is 1.2 mm/min.

3 Experimental results and analysis

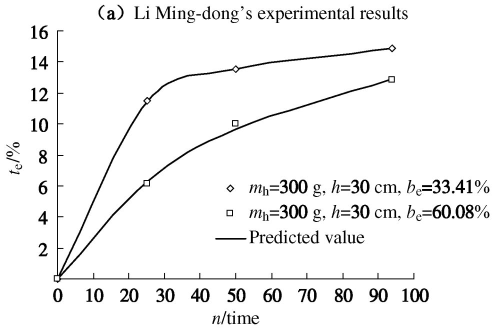
3.1 Test results of model for compaction density

(1) Influence of compaction times on compression ratio of EPS beads

EPS beads is a kind of material with opening hole structure and closed pore structure overlapping together, and it has elasticity and plasticity. The experimental data obtained by Li Ming-dong are analyzed in this paper, and shown in Fig. 5(a) and Fig. 6(a). Define: m_h is the mass of hammer, and h is the falling height of hammer. Some conclusions can be drawn in Fig. 5: (1) The compression ratio of EPS beads increases with the increasing compaction times, and then the increasing trend becomes stable gradually. (2) When the compaction times keep the same, the compression ratio of EPS beads decreases with the increasing volume ratio of EPS beads. EPS beads is a kind of plastic material. When the volume ratio of EPS beads is high, the mixed soil is similar to rubber soil, so EPS beads is difficult to be compacted. (3) Compared with the experimental results of Li Ming-dong, the compression ratio of EPS beads in the paper is smaller apparently. Except for the error, the grain grading and the water content of experimental sand can also be the main reasons for the differences.



(a) Li Ming-dong’s experimental results



(b) Author’ experimental results

Fig. 5 Relationship between compression ratio of EPS beads and compaction times

After making a regression analysis on the data of LI

Ming-dong and the Author, it is found that the relationship curve between compression ratio of EPS beads and compaction times can be expressed by hyperbolic model:

$$t_e = \frac{n}{a + bn} \quad , \tag{10}$$

In which a and b are the experimental constant. For a group of samples, 3～5 points should be measured and the values of a, b can be obtained. At last, compression ratio of EPS beads (t_e) can be predicted under arbitrary compaction times.

(2) Influence of compaction times on void ratio of mixed soil

Being similar to that of the conventional soil, the compaction energy can decrease the void ratio of mixed soil, which has a great influence on density. Fig. 6 shows the changes of void ratio of mixed soil under different compaction energies and compaction times. It can be concluded that the void ratio of mixed soil decreases with the increasing compaction times and the decreasing trend slows down gradually. The ability of compaction energy for compressing gap between soil particles and EPS beads is constant. With the increasing compaction times, the compression ratio of EPS beads increases gradually. When the compression ratio of EPS beads reaches a certain limited value, the main compaction energy can only be absorbed by elastic deformation, and plastic deformation can hardly absorb compaction energy, so the decreasing rate of void ratio reduces gradually. Moreover, when the volume ratio of EPS beads is more than 50%, the holes among EPS beads can hardly be filled by the sand particles. So the phenomenon that when n=94, e_1=0.85 is observed.

(3) Influence of compaction times on wet density of light weight soil with sand

In order to check the applicability of model, the predicted value of model for compaction density should be compared with the measured wet density under different compaction times. Define: Absolute error =｜Predicted value of model for compaction density–Measured wet density｜, Relative error= (Absolute error/Measured wet density) ×100%. Some conclusions can be drawn from Table 4: (1) The predicted value of model for compaction density is nearly close to the measured wet density, and the absolute error is only 0.003～0.051 g/cm^3, and the relative error is only 0.282%～5.267%; (2) The ideal density model cannot predict the variation of wet density of mixed soil under different compaction energies and compaction times, and it can hardly present compaction essence of mixed soil.

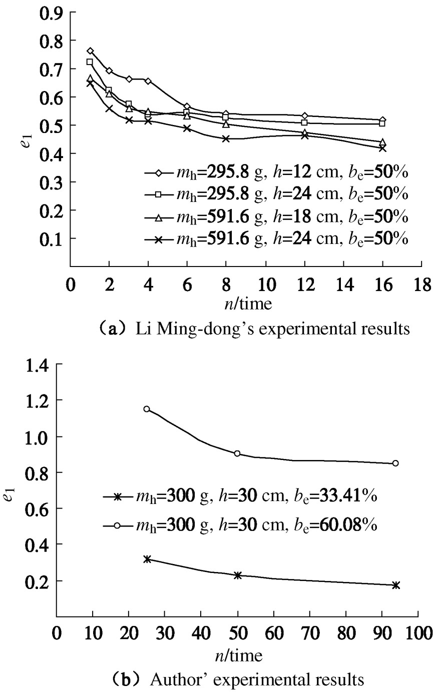


Fig. 6 Relationship between void ratio and compaction times

3.2 Physical-mechanical properties of light weight soil with clay under different compaction conditions

Fig. 7 shows that there are some errors between the predicted and measured values of wet density of mixed soil, but the difference isn't obvious, which verifies the feasibility of model for compaction density again.

Table 4 Comparison between predicted and measured values of model for compaction density

Mixed ratio	Compaction times	Measured wet density /(g·cm^{-3})	Predicted value of compaction density model /(g·cm^{-3})	Absolute error /(g·cm^{-3})	Relative error /%	Predicted value of ideal density model /(g·cm^{-3})
w=15%, b_e=33.41%	25	1.432	1.447	0.015	1.029	1.473
w=15%, b_e=33.41%	50	1.573	1.566	0.007	0.434	1.473
w=15%, b_e=33.41%	94	1.632	1.649	0.017	1.059	1.473
w=15%, b_e=60.08%	25	0.852	0.883	0.031	3.639	0.898
w=15%, b_e=60.08%	50	0.965	1.016	0.051	5.267	0.898
w=15%, b_e=60.08%	94	1.059	1.056	0.003	0.282	0.898

Taking predicted value for example: when the water content is 30%, the wet density under compaction times of 94 increases by 13.43% compared to that of the wet density under compaction times of 25; when the water content is 48%, the wet density under compaction times of 94 increases by 18.41% compared to that of the wet density under compaction times of 25.

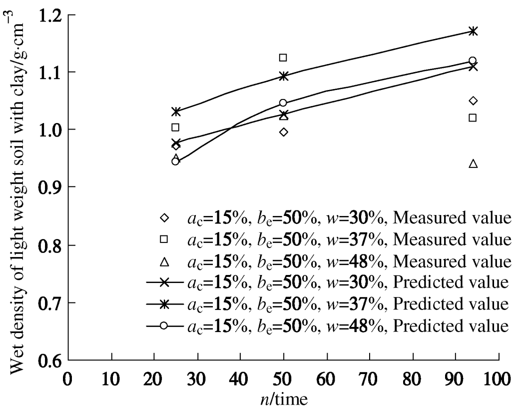


Fig. 7 Relationship between wet density of light weight soil with clay and compaction times

It can be concluded from Fig. 8 that the unconfined compressive strength of mixed soil increases with the increasing compaction times, but the increase trend is very tiny. When the water content is 30%, the strength under compaction times of 94 increases by 32.49% compared to that under compaction times of 25. When the water content is 48%, the strength under compaction times of 94 increases by 23.21% compared to that under compaction times of 25. Moreover, when the compaction times are the same, the water content increases from 30% to 48%, the strength of mixed soil increases first, and then decreases gradually, which indicates that the optimum water content indeed exists in the mixed soil. So there is an optimum water content for light weight soil, and its mechanism analysis is presented in Reference [12].

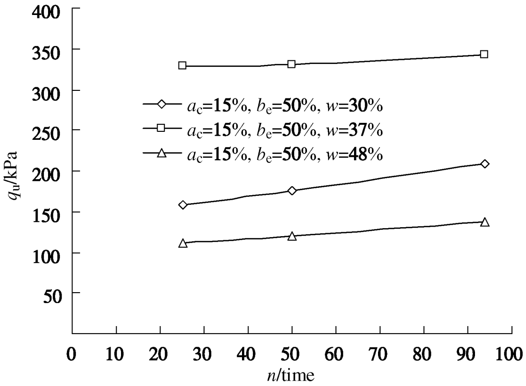


Fig. 8 Relationship between unconfined compressive strength and compaction times

3.3 Discussion

(1) A minitype compaction test has been used to simulate the standard compaction test (light and heavy compaction tests), and light weight soil with sand and light weight soil with clay are tested respectively. It is found that the range of EPS beads compression ratio is 6.13%～11.51% when the compaction times n=25, while it is 12.80%～14.87% when n=94. Apparently, EPS beads can be compressed but not destroyed even though the heavy compaction is used. From Fig. 8, it can be concluded that: For the samples with different water contents (when a_c=15%, b_e=50%), the strength increase range is 4.23%～32.49% when the compaction times increase from 25 to 94. Combining the measured results of EPS beads compression ratio unconfined compressive strength, it can be seen that the specified compaction times and compaction energy are fit for the compaction of mixed soil.

(2) The fact that the model for compaction density can precisely predict the wet density of mixed soil has been verified in the experiment, but the obtaining process of model parameters (w_1, t_e, e_1) is complex. However, in the spot construction process, it is necessary that the water content of soils should be w_{op} ±（2～3）%, and the density should be as high as possible. So, assume that: a) The water content of soil keeps the same in the compaction process, namely $w_1 = w$; b) The void ratio between soil particles and EPS beads is nearly close to 0 after compaction, namely e_1=0. So, Equation (4) can be simplified to:

$$\rho = \frac{1 + a_c + w + a_e}{\frac{1}{\rho_s} + \frac{a_c}{\rho_c} + \frac{w}{\rho_w} + \frac{a_e}{\rho_e}(1 - t_e)} \quad . \qquad (11)$$

Equation (11) is namely the simplified model for compaction density. Table 5 shows that the simplified model for compaction density can be used to predict approximately the wet density of light weight soil with sand and light weight soil with clay, and the absolute error is 0.005～0.107 g/cm^3, and the relative error is 0.457%～11.431%. To some extent, the simplified model for compaction density can be accepted entirely in the project. Meanwhile, the initial model can be simplified greatly, and it can indicate the plastic deformation of EPS beads soft inclusion.

Table 5 Comparison between predicted and measured values of simplified model for compaction density

Light weight soil with sand						Light weight soil with clay					
Mixed ratio (w=15%)	Compaction times	Measured wet density /(g·cm^{-3})	Predicted value of simplified model/(g·cm^{-3})	Absolute error /(g·cm^{-3})	Relative error /%	Mixed ratio（a_e=15%, b_e=50%, T=7 d）	Compaction times	Measured wet density /(g·cm^{-3})	Predicted value of simplified model/(g·cm^{-3})	Absolute error /(g·cm^{-3})	Relative error /%
b_e=33.41%	25	1.432	1.532	0.099	6.948	w=30%	25	0.972	1.017	0.045	4.607
b_e=33.41%	50	1.573	1.542	0.031	1.957	w=30%	50	0.995	1.038	0.043	4.365
b_e=33.41%	94	1.632	1.549	0.082	5.049	w=30%	94	1.050	1.055	0.005	0.457
b_e=60.08%	25	0.852	0.932	0.080	9.431	w=37%	25	1.003	1.016	0.013	1.256
b_e=60.08%	50	0.965	0.955	0.009	0.993	w=37%	50	1.125	1.037	0.088	7.854
b_e=60.08%	94	1.059	0.973	0.086	8.137	w=37%	94	1.019	1.052	0.032	3.187
						w=48%	25	0.952	1.015	0.063	6.621
						w=48%	50	1.025	1.034	0.009	0.891
						w=48%	94	0.941	1.049	0.107	11.431

4 Conclusions

(1) The compression ratio of EPS beads and the wet density of mixed soil increase with the increasing compaction times, and the increasing trend become slow gradually; while the void ratio of mixed soil decreases with the increasing compaction times. Under different compaction conditions, the enhance of wet density for light weight soil is accomplished by both the decreasing void ratio and the plastic compression of EPS beads soft inclusion, and the plastic deformation of EPS beads cannot be ignored.

(2) Based on material composition of mixed soil and soil compaction essence, the model for compaction density is established. In the experiment, it is found that the predicted value is close to the measured wet density. The absolute error is only 0.003～0.051 g/cm^3, and the relative error is only 0.282%～5.267%. The fact that the model for compaction density can precisely predict wet density of mixed soil under different compaction conditions is verified.

(3) Similar to those of light weight soil with sand, the wet density and unconfined compressive strength of light weight soil with clay increase with the increasing compaction times. When the compaction times n=25, the compression ratio range of EPS beads is 6.13%～11.51%; when n=94, the compression ratio range of EPS beads is 12.80%～14.87%. It is validated that standard compaction times and compaction energy are fit for the compaction of mixed soil, and EPS beads cannot be destroyed.

(4) Considering that the measuring process for parameters of model for compaction density (w_1, t_e, e_1) is complex, according to practical projects, assume the water content during the compaction process keeps the same and the hole between soil particles and EPS beads after compaction is close to 0, the model for simplified compaction density is put forward. The fact that the simplified model is fit for the practical projects completely and reflects the plastic compression deformation of EPS beads soft inclusion is proved.

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