Rock stress and deformation characteristics based on SVM and sports high-intensity interval training

Liu Ziyu¹ · Sun Qingyao²

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Abstract
Since the 21st century, with the rapid development of China’s domestic economy and the continuous improvement of people’s living standards, the development and construction of urban infrastructure are also faster and faster, and the requirements for the stability of foundations such as buildings, roads and bridges, subway, and high-speed railway are also higher and higher. In the southwest of China, due to the influence of terrain conditions, there are a large number of soil rock mixtures with uneven particle size change and complex particle composition. Understanding the mechanical properties of soil rock mixture and effectively measuring the strength and deformation parameters of soil rock mixture are one of the most important research topics. At the same time, in order to identify the soil rock mixture, the conventional Gauss Euclidean distance calculation method cannot fully reflect the structure of soil rock mixture, so an improved Gauss kernel function multiclass support vector machine (MSVM) method is proposed. On the basis of Gaussian radial, Gaussian kernel function is used to replace Euclidean distance in ranging. The attitude kernel function of Gaussian kernel function is established according to ranging. Many types of support vector machines (SVM) are constructed by a binary tree method to complete classification. The experimental results show that, based on the improved Gaussian kernel function, this paper discusses the high-intensity interval training, so as to achieve a good recognition effect, whether it has a promoting effect on improving the physical quality of college boys, and designs the training scheme to carry out experimental intervention on college boys, so as to provide a new training theoretical reference for school physical education teaching. It also provides a training method for college boys to improve their physical fitness.

Keywords Improved Gaussian kernel function · Soil rock mixture · College student · Optimization of physical training

Introduction
In a computer vision system, it can also be referred to as Gaussian function. Gaussian function has five important characteristics, which are especially suitable for initial image processing. These characteristics show that a Gaussian smooth filter is a very effective low-pass filter in the space and frequency fields and is used effectively by engineers in the actual image processing (Nawab et al. 2016). There are five very important properties of Gaussian function. Two-dimensional Gaussian function is rotationally symmetric. That is, the filter has the same smoothness in all directions. Generally speaking, because the edge direction of the image is not known in advance, it is impossible to judge whether more smoothing is needed in one direction than in the other direction before filtering. Rotational symmetry means that the Gaussian smoothing filter will not deviate in any direction in subsequent edge detection (Panda et al. 2020). Based on the improvement of the Gaussian kernel function of the structure of the earth rock mixture in practical engineering, this paper has a more comprehensive understanding of the mechanical properties of the mixture and becomes an important research topic of the soil rock mixture under the static load conditions of shear strength and stability analysis of deformation characteristics and the dynamic load analysis of shear strength and stability deformation characteristics (Papanikolaou et al. 2018).
in order to investigate the strength and deformation characteristics of foundation, one-dimensional compression test, laboratory shear test, triaxial compression drainage test, nondrainage test, etc. will be used. However, it is difficult to fully understand the mechanical properties of the earth rock mixture only from the macroscopic indoor test method. It is necessary to carry out the discrete element numerical simulation study on the mechanical properties of the soil rock mixture in different regions, analyze its mesomechanical behavior, and obtain the mesomechanical parameters of the numerical test model of the mixture (Prasad and Bose 2001). In order to reflect the strength deformation characteristics of the mixture more accurately in the actual engineering design, it is necessary to establish a static constitutive model suitable for the soil rock mixture based on the analysis of the indoor test data. In this paper, the basic physical properties test, medium-sized direct shear test, and PFC3D test are carried out for the soil rock mixture by means of indoor test, discrete element numerical simulation, and soil-based elastoplastic theory, respectively, which provides reliable calculation basis for practical engineering design. Good physical quality is very important for physical and health enhancement. Strengthening physical quality can improve the level of its own function (Prasanna et al. 2012). The human body is the embodiment of organic cooperation of different organ system functions during the exercise process, and the basis for judging the individual physical health level is physical quality. In short, in order to strengthen the physical health level of college boys and enhance their physical quality, we must keep a certain number of activities (Rattan et al. 2010). It is an urgent task for the school physical education curriculum to innovate a new way of exercise. The current research agrees that the students who participate in sports for a long time have better cardiopulmonary function than ordinary students. In order to ensure the personal heart and lung health function, how to use less time to get the best exercise results is the most important content of sports practical training (Puthiyasekar et al. 2012). Combined with the global fitness trend in 2020, the HIIT training method has entered the top 20 for the first time, slightly lower than the self-weight training method.

Materials and methods

Sample preparation

Soil rock mixture is a kind of soil with certain engineering scale, high content of coarse particles, low content of fine particles, and high strength. Earth rock mixture is widely distributed in China, and it is often encountered in practical engineering. The mechanical properties of soil rock mixture are complex, because the rock content, water content, initial void ratio, particle structure, stress state, and other factors have great influence on its strength and deformation characteristics (Ravindra and Mor 2019). In practical engineering, the mechanical properties of soil rock mixture are related to the safety and stability of practical engineering, so a large number of scholars at home and abroad have carried out extensive research on it. There are many methods to study the strength and deformation characteristics of soil rock mixture, but the results of various research methods have large errors. For example, the test results of field test have large deviation. The reason is that the field test is greatly constrained by the actual engineering, the boundary conditions of the whole test process are difficult to accurately control, and the test control conditions are also limited. Compared with the outdoor field test, the indoor unit test can better control the test conditions, and the test results are less discrete, which is more suitable for studying the mechanical properties of soil (Selvam et al. 2015). Therefore, some scholars carry out the indoor test research on soil rock mixture. At present, the main indoor test methods to study the mechanical properties of soil rock mixture are a medium-sized direct shear test and so on. In the laboratory testing on soil rock mixture, there are mainly two kinds of test soil sample: undisturbed soil sample and remolded soil sample. In this chapter, the undisturbed soil samples and remolded soil samples from the construction site of Baihetan Hydropower Station in S Province are taken as the research objects, and the basic physical properties of soil rock mixture are tested. Before the direct shear test, the particle size distribution screening test of soil rock mixture is carried out. At the same time, the particle size distribution curve of the earth rock mixture can also be compared with that of the earth rock mixture at home and abroad, and the differences of mechanical properties between the earth rock mixture in Baihetan Hydropower Station area and other areas in S Province are analyzed.

The soil sample of soil rock mixture used in the test is taken from the soil layer 1–3 m below the surface of a construction site of Baihetan Hydropower Station in S Province. The soil sample is brown yellow and hard. The density of soil is between medium density and dense, without bedding. The particle size distribution is not uniform, the content of 5–20 mm particles is more, and the particle size of individual particles is larger than 200 mm. In the process of undisturbed soil indoor medium-sized direct shear test, the soil samples used in the test are undisturbed soil samples (Ukah et al. 2019). The specific soil sampling process is as follows: two ring knives with a diameter of 300 mm and a height of 150 mm (diameter * height) are fixed, and then the ring knives are pressed into the soil by vertical compression, so as to achieve the effect of making undisturbed soil samples. Eight groups of natural undisturbed soil samples were collected from the construction site. The particle size distribution curve of soil sample is shown in Figure 1. According to the arrangement of rock content from small to large, the soil sample numbers of eight groups of soil are set as CK1, CK2, CK3, CK4,
CK5, CK6, CK7, and CK8, respectively. It can be concluded from the particle grading curve that the shape of the particle grading curve of the eight groups of soil samples is relatively consistent, the content of coarse-grained soil is higher, and the content of fine-grained soil is lower. According to the geotechnical test regulations, the soil belongs to the soil-rock mixture.

Improved Gaussian kernel algorithm design

The actual performance depends on the kernel function of support vector machine (SVM). Based on the geometric structure of kernel function, Amari proposed an improved Gaussian kernel function of support vector machine (SVM) to improve the performance of classical support vector machine. The purpose of support vector machine (SVM) is to improve the spatial resolution of boundary in isometric projection. This can improve the possibility of separating the two types of data collection. Suppose that the kernel function can be expressed as follows:

$$K(x, x_i) = p(x)p(x_i)K(x, x_i)$$  \hspace{1cm} (1)

Then in special cases, the kernel function of SVM is Gaussian kernel function, that is,

$$K(x, x_i) = \exp\left(-\frac{(x-x_i)^2}{\sigma^2}\right)$$  \hspace{1cm} (2)

Here, parameter $\sigma$ is shown. It is proved theoretically that the corresponding Riemannian measure tensor is

$$g_{ij}(x) = \frac{1}{\sigma^2} \delta_{ij}$$  \hspace{1cm} (3)

By improving the Gaussian kernel function, the Riemannian measure tensor is further changed into

$$\tilde{g}_{ij}(x) = p_i(x)p_j(x) + p^2(x)g_{ij}(x)$$  \hspace{1cm} (4)

In order to ensure that $P(x)$ has a large value around $SV$, we can construct the following result based on a sample, that is:

$$p(x) = \sum_{i \in SV} a_i \exp\left(-\frac{(x-x_i)^2}{2\tau^2}\right)$$  \hspace{1cm} (5)

Here, $\tau$ is the sum of all the support vectors in formula (5). Therefore, the Gauss kernel function derived from expressions (5) and (1) is used to map the low-dimensional input data space of SVM to the high-dimensional feature space. Thus, the boundary of the linear separation region is extended, and the precision of the high kernel function before the change is higher.

In fact, human perception is a stage process from rough to meticulous, so is the interpretation of facial expression. Considering the multiresolution approximation effect of MLS SVM and the improved Gaussian kernel function to improve the classification accuracy of SVM, this paper will introduce the MLS SVM and face recognition algorithm based on the advantages of improved Gaussian. Kernel function can reflect human cognitive process in nature.

Experimental scheme design

The purpose of indoor medium-sized direct shear test is to analyze the influence of vertical stress level on the shear strength of soil-rock mixture. In order to determine the shear strength parameters of soil-rock mixture, the medium-sized direct shear tests were carried out under the vertical pressure of 100 kPa, 200 kPa, 300 kPa, and 400 kPa, respectively. In order to study the influence of saturated state on the mechanical properties of soil-rock mixture, the shear rate was set at 0.08 mm/s.

Optimization design of college students’ physical training

According to the experimental needs of this paper, the influence of high-intensity intermittent training on the physical quality of college boys is taken as the research object, and 40 boys in two classes of public physical education are taken as the experimental object.

In the process of this experiment, taking public physical education as the teaching content, the students in the control group were given continuous training for 20 minutes in each class, and the students in the experimental group were given high-intensity intermittent training of designated movements. After 32 class hours of training, the required data were collected and sorted out, and 40 students in the two groups were tested for the items specified in the “student physical health standard.” All the data were collected and analyzed to compare the effect of two different training methods on the improvement of students’ physical quality.
Results

Analysis of stress-strain relationship of natural earth rock mixture

The curve of shear stress-shear displacement relationship obtained from the medium-sized direct shear test of natural earth rock mixture is shown in Fig. 2. According to the analysis of the figure, the shape of the shear stress-shear displacement curves of the eight groups of soil rock mixtures with different stone content is relatively consistent, and the failure mode is strain hardening type. The magnitude of vertical pressure has a great influence on the peak value of shear stress, and the variation rule is that with the increase of vertical pressure, the peak value of shear stress also increases. Under the action of low vertical pressure (100 kPa, 200 kPa), when the shear displacement reaches 20–30 mm (the shear strain is about 6.67%–10%), the shear stress reaches the peak value. Under the action of high vertical pressure (300 kPa, 400 kPa), when the shear displacement reaches 30–40 mm (the shear strain is about 10%–13.33%), the shear stress reaches the peak value. Through the indoor direct shear test, the relationship between shear stress and shear displacement of soil rock mixture under different vertical pressure is studied, and a similar conclusion is obtained. Figure 2c, d, and e respectively, show the shear stress-shear displacement curves of three soil rock mixtures with similar stone content. The void ratios of the three kinds of soil rock mixtures with similar stone content are 0.199, 0.314 and 0.347, respectively. Through the three diagrams, it can be concluded that with the increase of void ratio, the peak strength of soil decreases due to the decrease of compactness between soil particles.

The influence of rock content on the shear stress-shear displacement relationship of natural soil rock mixture is shown in Fig. 3. It can be concluded from the figure that under the action of four different vertical pressures, with the increase of stone content, the peak shear stress of soil rock mixture first increases and then decreases with the increase of stone content, which is similar to the conclusion of Nawab et al. Under the same vertical pressure, with the increase of rock content, the shear strength of soil first increases and then decreases. And it can be concluded from Figure 3 that the critical stone content affecting the shear strength of soil is about 73%.

![Shear stress-shear displacement curve of natural soil sample](image-url)
Analysis of stress-strain relationship of saturated soil-rock mixture

In the medium-sized direct shear test of saturated soil-rock mixture, under the action of vertical pressure, the sample is kept in the shear box filled with water for 24 hours. The saturation of the soil-rock mixture is close to 96%, which meets the test requirements. Through the analysis of shear stress-shear displacement curve 4 obtained from the medium-sized direct shear test of saturated soil-rock mixture, it can be concluded that the shape of the shear stress-shear strain curve of the eight soil-rock mixtures with different particle sizes used in this test is relatively consistent, and the failure mode is strain hardening type, and the variation law is consistent with the test results of natural soil-rock mixture. However, the peak shear stress of saturated soil-rock mixture is lower than that of natural soil-rock mixture. The main reason is that with the increase of soil saturation and water content, the shear strength of soil decreases.

The influence of rock content on the shear stress-shear displacement relationship of saturated soil-rock mixture is shown in Fig. 5. The conclusion of saturated soil-rock mixture is consistent with that of natural soil-rock mixture, so it will not be repeated here.

In order to compare the peak strength relationship between the shear stress and shear displacement of natural earth-rock mixture and saturated earth-rock mixture, eight groups of direct shear test data of different particle grading in this test are compared and analyzed, as shown in Figure 6.

It can be seen from the figure that the relationship between shear stress and shear displacement of the earth-rock mixture under four vertical pressures is that under different particle grading and rock content conditions, the test curves obtained by natural earth-rock mixture and saturated earth-rock mixture are consistent, and the failure mode is strain hardening type, and the vertical pressure has a great influence on the peak value of shear stress. The change rule is that with the increase of vertical pressure, the peak value of shear stress increases. The reason for this test result is that the moisture content in soil particles increases.

Analysis of shear strength parameters of earth rock mixture

The shear strength parameters of natural soil samples and saturated soil samples are analyzed, respectively. When determining the shear strength values of samples under different
vertical pressures, the parameter acquisition methods introduced in "geotechnical test regulations" are adopted: the peak point on the shear stress-shear displacement curve is taken as the shear strength $s$ of soil under the test conditions. If there is no obvious peak point, the shear stress corresponding to the shear displacement of 10% of the sample height is taken as the shear strength $s$, so that the relationship between the shear stress peak and the vertical pressure of each group of soil samples can be obtained. The relationship between shear strength and vertical pressure of eight groups of natural earth rock mixture with different stone contents under four different vertical pressures is obtained, as shown in Figure 7.

In the case of high stone content, the shear strength increases first and then decreases with the increase of stone content, and there is a critical shear strength in the process of shear strength change, and the stone content under the shear strength can be approximately called the peak stone content. The reason for the above variation may be that the rock content is the main factor affecting the shear strength of soil in the process of the rock content increasing to the critical rock content. When the rock content increases to more than the peak rock content, the compactness of soil almost reaches the highest value, and the relationship between shear strength and vertical pressure is shown in Figure 8.

Optimization effect analysis of college students’ physical training

Through the investigation in the early stage of the experiment, the age, height, and weight of the students were collected and tested (the test instrument is a special instrument in the national physique test school, which can skillfully use the machine and operate in strict accordance with the instructions to ensure the accuracy of the data). Then the data of the experimental group and the control group were tested by an independent sample $t$-test, and the results are shown in Table 1. The $P$ values in the test indexes were all greater than 0.5, and there was no statistically significant difference, which ensured the
validity of the experimental results. The grouping of the experimental objects was reasonable, and the experiment could continue.

It can be seen from Table 2 that the average score of the students in the experimental group is 8.16 seconds before the experiment and 8.07 seconds after the experiment, which is greatly improved compared with that before the experiment. Through the corresponding t-test analysis, P value is less than 0.01. From a statistical point of view, the students in the experimental group have very different scores in running about 50 meters. The average score of the control group before and after the experiment is 8.35 seconds and 8.33 seconds after the experiment, which also has a significant improvement, compared with before the experiment. After t-test of corresponding samples, the P value of control group was 0.06 > 0.05; no significant difference was found.

Fig. 5 Shear stress-shear displacement relationship of different stone content

Among college students, long jump is an important index to test the strength and explosive power of students’ lower limbs and one of the important indicators of national physical strength test. There is no obvious difference between the two groups before the test. Therefore, from Table 3, the average score of the students in the experimental group is 212.9 cm, and the pretest is 214.9 cm, and the corresponding sample t-test is conducted. P value was 0.00 < 0.001. From the statistical point of view, there are significant differences between the experimental groups before and after the experiment. The results of the comparison group were 209.9 cm in the men’s long jump preliminary, and the average score of the post test was 210.1 cm, which also improved from the data. The t-test of the corresponding sample shows that P value is 0.511 > 0.05. From the statistical point of view, there was no significant difference in the long jump scores before and after the control group.

As shown in Table 4, after 8 weeks of high-intensity interval training intervention, the scores of the two groups before and after the experiment and the scores of the experimental group before and after the experiment and the control group showed a very significant difference: the P value of the corresponding sample after t identification = 0.003 < 0.01. The results of the contrast group also improved after the experiment, but after the corresponding sample t-test, P = 0.052 > 0.05; there was no significant difference from the statistical point of view.
Discussion

Analysis of the influence of college students’ physical training optimization on the performance of 50-meter race

The 50-meter race is an important index of speed quality in the National Students’ physical health standard and the national physique measurement standard. This is because it can effectively reflect the students’ rapid movement ability and rapid reaction ability, which is of great significance to the physical exercise function. From the perspective of modern training, the development level of speed quality plays an important role in the process of training and competition, and it is also of great significance to the level of competition. Good speed quality can help athletes master reasonable and effective sports skills (Biney and Christopher 1991).

As a kind of anaerobic exercise, 50-meter running has the characteristics of instant explosive power and high load intensity. As a full, fast, and explosive short-term training technology, high-intensity intermittent training will increase the human body’s demand for oxygen and produce a state of hypoxia, thus continuously stimulating the incomplete recovery of the human body and promoting the development of energy, and improve the supply capacity of glycolysis energy supply system (Chadha 1999). After a period of high-intensity exercise, the students’ reaction speed was repeatedly trained to stimulate muscle contraction, improve the nerve control of muscle, and enhance muscle strength and coordinate joint movement of large and small muscle groups, so as to improve the ability of running 50m (Demirel et al. 2008). At this time, college students are at the end of their growth and development and have gone through the period of rapid development of speed quality, which shows that the growth and development of physiological growth students have little influence on the speed quality (Drury et al. 1991). Therefore, the high-intensity intermittent training plays a key role in improving the performance of the experimental group.

Through the analysis of the experimental results, we can see that the two groups of students have improved significantly after training, but after the experiment, the high-intensity intermittent training group has improved significantly than before, which shows that this training is more conducive to improving the speed quality of students (Edet and Offiong 2002). At the same time, compared with before training, high-intensity intermittent training can effectively improve the speed quality of students,
while the traditional physical education training group has some improvement, but the performance is not obvious and the improvement of students’ speed quality is not significant.

**Analysis of the influence of college students’ physical training optimization on the results of standing long jump**

Strength quality is the basis of human movement and other qualities. Standing long jump is also an important part of the national physical fitness test (Ediagbonya et al. 2015). The premise of improving the quality of standing long jump is that we need to use the leg muscle strength and speed and actively cooperate with the leg muscle.

So students can carry out lower limb support and push force, generate brake, and then suddenly break out and strengthen leg strength and body strength exercises. The big muscle group drives the small muscle group to effectively stimulate the gluteus maximus and enhance the leg strength and explosive force of students. After the experiment, there is no significant difference between the two groups of students in the high-intensity intermittent training (Godt et al. 2006). The reason may be that the time period of the two tests is different, the temperature is higher in summer, after several weeks of training, the weather turns cold, and the human body enters the physiological rest stage, which will make their body stiff, leading to a significant difference before and after the results.

After 18 weeks of salsa dance and high-intensity interval training for college girls, the results show that the performance of the two groups of students in standing long jump has improved, which shows that the two training methods play a positive role in the improvement of students’ explosive power and that high-intensity interval training can enhance muscle strength. And effective stimulation to achieve the purpose of improving the performance of long jump (Huang and Jin 2008). Compared with before training, high-intensity interval training and traditional physical education training can effectively improve students’ explosive power, but the improvement effect of high-intensity interval training is more prominent than that of traditional physical education training.

**Analysis of the influence of college students’ physical training optimization on vital capacity performance**

Vital capacity refers to the maximum ventilation capacity, so experts generally believe that if a person’s vital capacity is in a state of decline, that person’s ventilator capacity may decline. Good vital capacity is one of the important indexes to evaluate physique and health.
The normal respiratory system is the basic condition of exercise. Under the stimulation of eight weeks of high-intensity intermittent training, in order to adapt to the enhancement of exercise intensity, the physiological reaction of human body changes, the breathing depth increases, the breathing rate accelerates, and the strength of breathing muscles are enhanced (Karim 2011). The potential breathing ability of students is stimulated, and the lung function is improved. High-intensity interval training is to keep the body in a state of incomplete recovery. It is a repeated high-intensity exercise adjusted by increasing rest or low-intensity exercise. During the interval, the aerobic system provides energy for the respiratory system and improves the respiratory capacity of the lung.

The test results show that high-intensity intermittent training can significantly improve the quality of human ventilator (Khalid et al. 2017).

Table 1: Before the experiment, students’ physical health test results of the two groups were compared (mean ± SD).

| Index                        | Experimental group (n = 20) | Control group (n = 20) | P value |
|------------------------------|----------------------------|------------------------|---------|
| Age (years)                  | 18.35 ± 0.81               | 18.35 ± 0.74           | 0.100   |
| Height (cm)                  | 173.53 ± 3.98              | 175.64 ± 4.29          | 0.115   |
| BMI (weight/height 2)        | 22.12 ± 4.42               | 21.47 ± 3.29           | 0.601   |
| Weight (kg)                  | 65.28 ± 12.79              | 67.76 ± 11.98          | 0.530   |
| Vital capacity (ml)          | 4059 ± 705                 | 3980 ± 842             | 0.747   |
| 50 meters (s)                | 8.16 ± 0.65                | 8.35 ± 0.55            | 0.328   |
| Standing long jump (cm)      | 212.9 ± 22.0               | 209.9 ± 23.2           | 0.586   |
| Sitting forward bending (cm) | 9.4 ± 7.3                  | 9.04 ± 6.2             | 0.871   |
| Pull-ups (times)             | 7.0 ± 6.2                  | 6.45 ± 4.39            | 0.748   |
| 1000 (s)                     | 259.4 ± 24.4               | 262.9 ± 14.8           | 0.588   |

(c) Soil sample with 73.0% rock content

(d) Soil sample with 73.3% rock content

(e) Soil sample with 73.7% rock content

(f) Soil sample with 76.2% rock content

Fig. 8 Shear strength of saturated soil rock mixture under different vertical pressures.
Suggestions on the optimization of college students’ physical training

In order to better play the role of high-intensity interval training for physical fitness and further promote the physical development of college boys, the following suggestions are put forward.

Teachers of public physical education can arrange and design reasonable high-intensity intermittent scheme according to the characteristics of the course teaching and the specific situation of different classes and students, combine high-intensity intermittent training with college physical education classroom, enrich the means of College Students’ physical health training, optimize the training mechanism, and make it more reasonable and scientific (Magesh et al. 2017).

It is suggested that when designing the high-intensity interval training program, we should design the training program comprehensively and pertinently and purposefully add the exercises to improve the upper limb strength and mixed oxygen endurance quality.

Due to the special intensity of high-intensity interval training, teachers should lead students to prepare for activities, warm up their bodies comprehensively, control the intensity of exercise, train in strict accordance with the training plan, and prevent sports injuries in the process of exercise (Muhammad et al. 2016). Due to the personality differences among students, personality differences should be taken into account in the formulation of high-intensity interval training plan; we should also pay attention to monitoring the physical activities and diet beside the training.

The HIIT training method is combined with college students’ physical health standard project. Teachers should give full play to students’ initiative and arouse their interest. Because the HIIT training method is widely used in fitness, with the characteristics of novel action innovation, through flexible training methods, let college students develop the awareness of joining sports, in addition to sports class, also let students go to the gym or track and field independent practice, and let students understand the basic master of a new way of training and fitness.

Conclusion

Based on the improved Gaussian kernel function, this paper carried out the optimization experiment of soil rock mixture structure and college students’ physical training and studied the shear characteristics of natural soil rock mixture and saturated soil rock mixture. At the same time, the discrete element PFC3D software is used to study the mesoscale numerical test of the indoor test of the soil rock mixture, and the strength and deformation characteristics of the soil rock mixture are analyzed from the perspective of mesoscale numerical test simulation. Based on the nonlinear stress-strain relationship and dilatancy characteristics of soil rock mixture, an elastoplastic constitutive model is established on the basis of the modified Cambridge model. The shear stress displacement curves of natural soil rock mixture and saturated soil rock mixture show

Table 2  Comparison of boys’ 50-meter running results before and after the experiment (n = 40)

| Index          | Experimental group | Control group     |
|---------------|--------------------|-------------------|
|               | Before the experiment | After the test  | $P$ value | Before the experiment | After the test  | $P$ value |
| 50 (s)        | 8.16 ± 0.65        | 8.07 ± 0.63       | 0.00**     | 8.35 ± 0.55           | 8.33 ± 0.52     | 0.065     |

Table 3  Comparison of boys’ standing long jump scores before and after the experiment (n = 40)

| Index          | Experimental group | Control group     |
|---------------|--------------------|-------------------|
|               | Before the experiment | After the test  | $P$ value | Before the experiment | After the test  | $P$ value |
| Standing long jump | 212.9 ± 22.0        | 214.9 ± 22.9      | 0.00**     | 209.9 ± 23.2           | 210.1 ± 23.2     | 0.083     |

Table 4  Comparison of vital capacity of male students before and after the experiment (n = 40)

| Index          | Experimental group | Control group     |
|---------------|--------------------|-------------------|
|               | Before the experiment | After the test  | $P$ value | Before the experiment | After the test  | $P$ value |
| Vital capacity (ml) | 4059 ± 705         | 4239 ± 570       | 0.003**    | 3980 ± 842            | 3995 ± 835      | 0.051     |
strain hardening law, and the peak shear stress increases with the increase of vertical pressure. With the increase of stone content, the peak shear stress of the soil rock mixture increases, but when the stone content increases to a certain extent, there is an optimal stone content, and then the peak shear stress will decrease. Because of the design action of high-intensity intermittent training based on the improved Gaussian kernel function in this study, after 8 weeks of high-intensity intermittent training and continuous training, the peak shear stress of the soil rock mixture increases. This training method has no significant improvement in the development of male college students’ 1000-meter performance (mixed oxygen endurance quality) and pull-up (upper limb strength). Because the designed movements may not be enough for students’ upper limb training and there is no high-intensity intermittent training movement designed for college students’ upper limb strength and mixed oxygen quality, the eight-week training cannot effectively explain the improvement effect of this kind of training on college students’ mixed oxygen endurance quality and upper limb strength quality.

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Declarations

Conflict of interest The authors declare that they have no competing interests.

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